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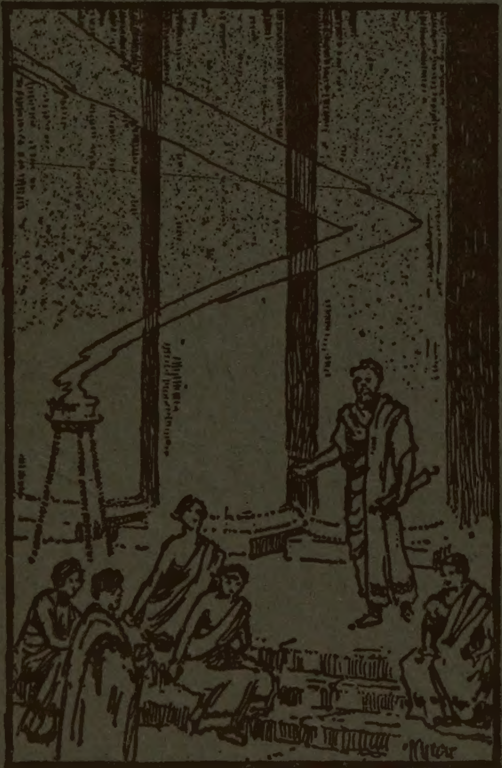

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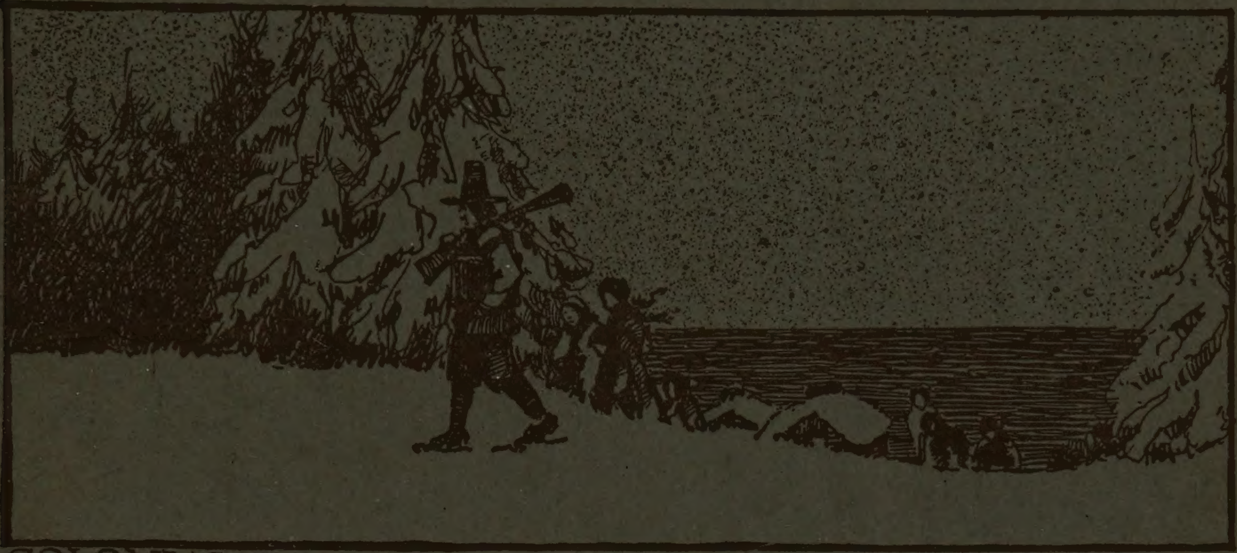
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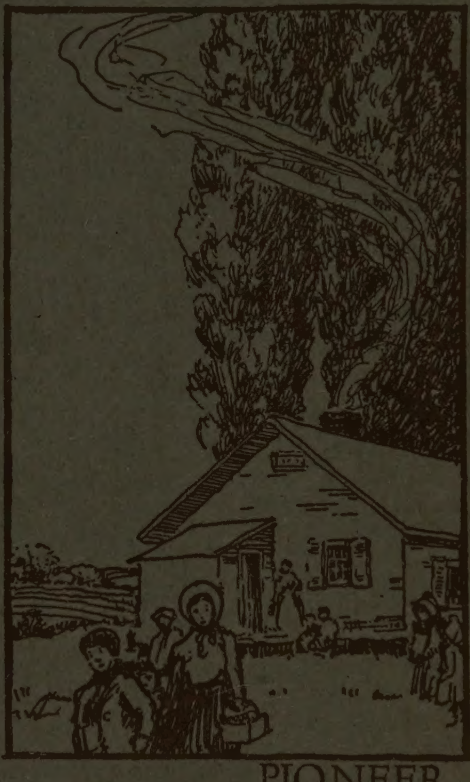
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T.W. STEVENS

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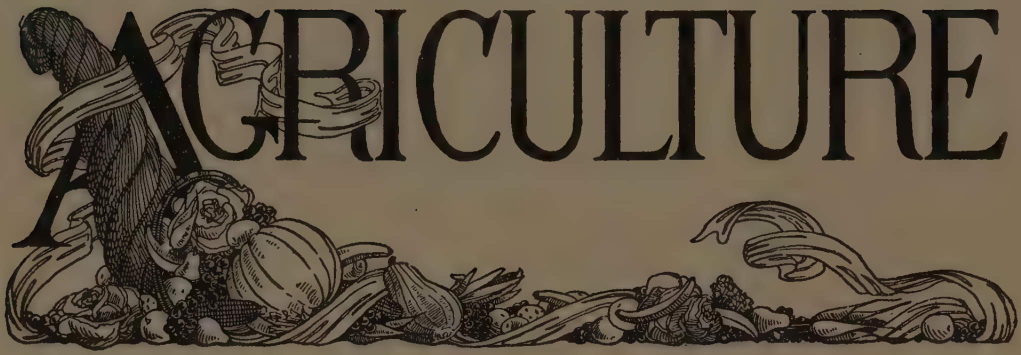
CHAPTER ONE

AGRICULTURE



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SOILS AND TILLAGE

1. Our Dependence upon the Soil. Practically everything that we eat or wear comes directly or indirectly from the soil. If we should make a list of all of our common foods, such as bread, meat, milk, eggs, butter, vegetables or rice, we should find that very nearly all of them may easily be traced back either to the soil itself, or to some animal which lives upon foods produced by the soil. The same is true of the cotton, wool, linen and silk, of which our clothing is made, or even of the leather in our shoes.

All other people are dependent upon the soil just as we are for their food and clothing; and even the lower creatures, which do not wear clothing, still receive their food from it.

The maps in our geographies often reveal this same truth though we may never have noticed or understood it. People tend to gather in those parts of the world where the soil produces most bountifully. They are regions of dense population and many cities; while in those sections where the soil is not productive, the population is usually sparse and the cities far apart.

When people move to new countries or to different sections of the same country, it is very often because they think they can raise better crops in the new location than in the old one. It may be even that our own present home was chosen either by ourselves or by our parents or grandparents for this very reason. A discussion of this topic in class will prove very interesting, especially if the children decide finally that it was really the soil which in the first place attracted their parents or their parents' parents to the neighborhood in which they live and thus determined in what part of the world their own lives should be laid. This discussion should be followed by another as to what their parents and neighbors are actually securing from the soil.

In this discussion it should be brought out clearly that while only a part of their food and clothing is actually produced on their farms, they exchange the surplus of what these farms produce for everything else they need. Thus will the vital relation of the soil to their own lives be established; and not until this relation is clearly understood are the pupils ready to take up the study of the soil, itself.

2. What the Soil Is. If we warm a sample of fresh soil in a dish, it will gradually lose weight as the moisture evaporates from it; and if, after it has become perfectly dry, we put it on a hot stove, it will soon begin to smoke. At the same time, we shall know by the peculiar odor that something in the soil is burning. Finally the burning will cease; and after this no amount of heat that we are able to apply seems to have any effect upon it.

Children are easily able to perform this simple experiment; and they are likewise able to reason to a true conclusion concerning it. They know that plant materials, such as straw, dried grass or leaf mold, will burn; while mineral substances, as sand or perhaps ashes from the stove, will not do so. When they have decided that the soil consists simply of mineral and vegetable matter mixed together, they will have laid hold of a fact of the highest importance concerning it.

The experiment, however, should not end here. When they examine and handle the mineral matter remaining in the dish, they will notice that it feels gritty to the touch and that the particles, or grains, are not at all equal in size. Some, as the grains of sand or gravel which are nearly certain to be present, are large and coarse while others are finer even than the finest flour; and when examined with a good hand lens, they are seen to differ in color as greatly as in size.

(a) CLASSES OF SOIL. We may now ask the children to classify this soil according to its *texture*; that is, according to the *size of the particles* which predominate in it. Tell them that the coarsest particles are called sand, that the medium-sized particles are called silt and that the finest ones are called clay. A soil in which sand predominates is called a sandy soil, while if silt is most abundant, it is called a silt soil, and if clay, it is called a clay soil. If the amount of sand is nearly or about the same as that of the silt and clay together, we call it a *loam*.

(b) EXPERIMENT. How can the pupils tell which kind of particles is most abundant? Have them get three glass jars and put about a cupful of the soil sample in one of them. It should then be filled with water and left over night so that all of the particles may be loosened from one another. The next day shake this jar vigorously, allow it to stand one minute and then pour off the water from the rock particles, which have settled, into the second jar. Allow the second jar to stand one hour, then pour the water off into the third one. After twenty-four hours, examine the three jars. In the bottom of the first is the sand, in the second is the silt and in the bottom of the third, which still contains the water, is seen the clay. The relative amounts may now be easily estimated; but the children should be required to explain just why the particles of different sizes may be separated in this way.

(c) HUMUS. If now the children are asked, as they really should be, to try to separate the vegetable matter from the rock material in some of the soil that has not been burned, they will find the task difficult. They may find here and there a fragment of a stem or leaf or the fiber of a grass root; but the larger part by far of the vegetable matter will escape the sharpest eyes. The reason for this is that it is partially decayed and it has changed so greatly in appearance that it no longer resembles the plants from which it was formed. Instead, it is very dark or nearly black in color with a tendency to be waxy and to inclose or adhere to the rock particles about it.

This dark colored, partially decayed vegetable matter is known as *humus*. Usually it comprises only about five per cent or even less of the soil, the rock material making up the remainder; and this is another reason why it is so hard to see. Yet, while the percentage of humus is surprisingly small, its importance in the soil is, as we shall see later, very great.

It should be made clear that while the humus which the soil contains tends always to make it darker, the color of the soil is determined not by this alone, but by the rock material as well. In many parts of the South, for example, the rock material is red in color, and because of this the soil, itself, is red. However, it is still true that the greater the amount of humus which the soil contains, the darker it appears. Many of these red soils are fully as fertile as the black ones of the corn belt.

3. How the Soil was Made. The particles of rock material in the soil have not always existed in the form in which we now find them. Rather, they are merely tiny fragments of what were once great boulders and enormous rock masses.

Then by what means were these rock masses broken apart and finally pulverized to dust? One by one, the skilful teacher will draw out the facts below in answer to this important question, supplementing the children's knowledge only where necessary.

(a) WORK OF THE ATMOSPHERE. The air played an important part in this great work. Many rocks contain iron, which unites with the oxygen of the air just as does the iron in a nail when it rusts. By this the rocks are weakened so that they gradually crumble away.

(b) Work of Water. Water helped to break them down. All rocks are porous to some extent; and in case water enters the pores and freezes there, pieces are chipped or cracked off for the same reason that a jug or water pipe bursts if water freezes in it. The reason ought of course to be discussed.

GLACIER

(c) Work of Heat. Heat and cold have had a share in breaking the rocks apart. How often have we seen dishes cracked by pouring hot water upon them so that parts of them became hot while other parts were cold! Rocks, like dishes, break easily as a result of unequal heating; and since their temperatures are ever changing, they are constantly subjected to this condition.

(d) Work of Ice. Great sheets of ice, many thousands of square miles in area, which have in past ages moved slowly over certain parts of the country, have ground large quantities of rock material to fragments or even to powder. An excellent example of these ice sheets, which are called *glaciers*, is found today in Greenland. It is said to be more than ten times as large as the entire State of New York and in some places many hundreds of feet in thickness. But we do not need to go to Greenland or other foreign lands to see glaciers. They abound in Glacier National Park in the northwestern part of Montana, and in other regions in the Rocky and Sierra Nevada Mountains. There are also extensive glaciers in Alaska. All these glaciers are now grinding up the rocks upon which they rest, just as many of the rocks were ground up long ages ago.

(e) WORK OF PLANTS AND ANIMALS. Finally, we must not overlook the *work of plants and animals* in breaking down the rocks. The roots of plants force the rock fragments apart; and when they decay, the air can enter more freely to act upon the rock material. In the same way, the air is admitted through the burrows of animals.

(f) TRANSPORTATION. In this discussion it should also be shown that three of the agents named above have not only helped in pulverizing the rocks but have also helped to carry incredible quantities of the fragments and powder from the places where it was formed to others perhaps far distant. We know, for example, that the Appalachian mountain system has lost more material than we now see. What has become of it? It has been carried away by the *water* and has helped to build up States in the Mississippi valley as well as the Atlantic coastal plain. In the north part of our country are extensive areas whose soil was brought from distant places by the *glaciers*. And in the western part of the Mississippi valley are large sections whose soil has been brought by the *air* — that is, by winds — from considerable distances. The children, after discussing these things, can easily see the distinction between *transported* soils, which are brought from elsewhere, and *sedentary* soils, which have been formed just where we now find them.

(g) Bacteria. After the source of the rock material in the soil has been studied as suggested above, attention must of course be turned to the humus which we have found in it. How was it formed? We have already learned that it was produced by the decay of vegetable matter; but it is important to understand that all decay is really caused by *bacteria and fungi*, which are plants so exceedingly small as to be invisible except through the microscope. The truth is that the amount of dry soil which we might lay upon a dime often contains from fifty millions to one hundred millions of these tiny plants. But for them, nothing could decay; and hence there would be no humus in the soil at all.

4. Functions of the Rock Material and the Humus. Now that we have found out how the rock particles and the humus in the soil were formed, the question must arise in our minds: "How is it possible for a mixture of such materials as these to work together to sustain the life of the earth?" Nothing in fact seems more truly impossible than this; yet we know that in some strange way they really do accomplish this wonderful work.

Let the children try to reason out how this is possible. An occasional helpful suggestion on the part of the teacher will of course be necessary; but with this assistance, they will work their way unerringly to some such sound conclusions as are stated below:

(1) Since the rock particles usually comprise about ninety-five per cent of the soil, they give to it its body and to the plants which grow in it, the necessary foothold. Thus the first need of plants is provided for.

(2) As the rock particles are usually of many different kinds, they might be expected to contain a variety of the substances, or elements, which plants use as food.

(3) Since rock particles do not dissolve in water, it appears at first that there is no way by which plants can secure the food elements which these particles contain. It will be for the teacher to show here that the humus now

begins to play a part, for as it decays, acids are formed which are able to dissolve the particles of rock. Thus the humus enables plants to take food which they could not otherwise get at all.

(4) The fact that the humus consists of decaying plants suggests that it should, like the rock material, contain elements of plant food. This is known to be true.

(5) We know that plants need moisture; and it can be easily shown that the ability of the soil to hold moisture depends almost altogether upon the humus in it. To make this clear, have the children bring two samples of soil, one of which should be rich, such as we usually find in a pasture, while the other should be taken from a clayey side hill or knoll. The first sample will of course contain much more humus than the other. Each should be thoroughly dried in the air. Then have the children put each sample into a tin can having holes punched in the bottom, filling it level full, and pour water slowly into the cans until it begins to run out at the bottom, measuring carefully the amount poured into each one. The soil containing much humus will take up and hold much more water than the other.

(6) Finally the humus keeps the soil loose and open so air may circulate through it. This is important because plant roots must have air. That it is true may be shown with the soil samples used above. Dry them again carefully and put each into a water-tight can or tin or glass, filling it level full; then pour water into each one until it runs over. The soil requiring most water will be the one which contained most air, for the water simply fills the space previously occupied by the air; and in this case it will be found to be the sample which contains much humus.

We see then that the rock particles and the humus between them really provide for every need of plants. However, it is important to pause here to discuss the relative importance of the rock material and the humus in the soil. As the foregoing points are reviewed, it will be seen that, notwithstanding the percentage of humus in the soil is very small, the part which it plays in sustaining plant life is surprisingly large.

5. Conditions of Fertility. The question of the fertility of the soil is the one which must overshadow all others in any soil study. It may be introduced by a discussion in class as to whether all the fields of the neighborhood are equally rich or fertile. It will soon be found that some of the pupils know of certain fields or parts of fields that are either more or less productive than adjoining lands; and all will be quite positive that soils differ greatly in their productiveness even though they may look very much alike.

Following this should come the question of what conditions must exist in a soil in order that it be fertile. Bring out then, in order, the points below, since they are easily deduced from what the children already know:

(1) The rock particles must be of such kinds as contain in sufficient amounts the food elements which plants must receive from them. It is really true that the infertility of many soils can be traced to the fact that the rock particles do not contain all of the food elements which plants require from this source.

(2) Much humus should be present since it provides necessary plant food not found in the rock material.

(3) Bacteria should be very numerous for they not only hasten the decay of the humus, making its food elements available to plants, but the acids which they produce dissolve food elements from the rock material, as has been already explained.

(4) Moisture must be present in suitable amounts for plant growth. This means that there must not be too much, as in a swamp, nor yet too little, as in a desert.

(5) Air must be able to circulate freely through the soil. The infertility of many sticky clay soils is due to the fact that air cannot pass into or through them as freely as necessary.

It should be made clear that in fertile soils *all* of the five conditions named above always exist. Moreover, if any one of them ceases to exist from any cause, the soil becomes infertile. When this is understood, the boys and girls are already able to work out the following topic without help.

6. How Soils Become Infertile. This question calls for nothing so much as a test of the children's reasoning powers. Supposing that all five of the conditions of fertility named above exist in any given soil, what would or could put an end to these conditions or any one of them?

How, for example, can the supply of plant food, which the rock material furnishes, be cut off? The first answer that will be suggested is that this food supply might in time become literally exhausted; but this clearly cannot happen since the amount of rock material under our feet is enormous and seems as great in infertile soils as in fertile ones. Wait, then, until some alert boy or girl suggests that without the soil bacteria to produce acids the rock material would not be dissolved. The conclusion will be that without a sufficient number of bacteria, the supply of food which plants take from the rock particles would be cut off wholly or in part.

This is of course true, but it calls for further thought as to how the number of soil bacteria might become reduced to a point where crops would suffer. It will be decided that since bacteria feed upon decaying plant material, their number would become smaller as the amount of humus in the soil diminished; that is, a soil deficient in humus would also be deficient in bacteria. But how can the soil become deficient in humus? Obviously, by failing to put back into it a sufficient amount of plant matter to replace that lost by decay or otherwise.

Follow this by an inquiry as to whether other bad effects would probably follow a depletion of the humus supply. The children have already found that the amount of humus in the soil determines its moisture-holding capacity and also the amount of air space in it. Hence they will conclude that an insufficient amount of humus will put an end to four out of the five conditions of fertility.

It is time now for the class to turn their attention to the effect of taking crops from the soil year after year and selling them. It is important that they understand clearly that all crops are really made up of the elements which plants take for the most part from the soil. It follows, then, that if crops are taken off and sold, the soil is gradually robbed of the plant food which it contains.

The final conclusions as to how soils become infertile will be as follows:

(1) The supply of humus in the soil is not kept up.

(2) The soil is gradually robbed of the plant food which it contains, by the removal and sale of crops.

7. Finding the Needs of the Soil. In case a soil is low in fertility, how can we tell what is the matter with it or what is needed to make it fertile again?

Remembering the preceding section, we should of course try first to ascertain whether the humus supply is too low. Ask the class to think out some plan for determining just how much humus any given sample of soil contains. The usual method — that of drying and weighing the sample, then burning the humus out of it and weighing again — they should be able to strike upon without help. However, this is rather difficult, and so we generally judge the amount of humus by other evidence, most of which they already know or suspect, but which has not yet been discussed in the class. By skilful questions the points below may be brought out easily:

(1) Humus is nearly or quite black and hence imparts a dark color to the soil. In general, the darker a soil, the more humus it contains.

(2) Humus has a peculiar, agreeable odor. This good "earth" smell is a reliable sign of a considerable humus supply.

(3) If the supply of humus is low, the soil tends to be sticky when wet and to bake hard, forming many clods, when dry. A field whose soil gives much trouble of this kind may be put down as deficient in humus.

After deciding whether any field which we are examining needs more humus, we next try to find out whether the soil contains a sufficient amount of plant food. The elements which plants must have in order to make healthy growth are ten in number; but of these only three are so important as to demand particular notice. They are *nitrogen*, *phosphorus* and *potassium*. If time permits, they should be studied in some detail; or certain pupils should be asked to find out as much as possible about them and report their findings to the class.

Crops do not use more of these elements than of others, nor need them worse. Rather, their importance in soil study is due to the fact that they are the first elements as a rule to become deficient in a soil as it becomes infertile.

How can we tell whether a field is lacking nitrogen? The simplest way, and one which the class may be able to think out for themselves, is to put some fertilizer upon it *which contains nitrogen*, but neither phosphorus nor potassium, and watch the effect upon the crops.

If nitrogen is deficient in the soil, the fertilizer should of course increase the yield of the crop receiving it. The fertilizer commonly used is Chili saltpeter, or sodium nitrate.

In the same way, if we try a fertilizer *containing phosphorus* but neither nitrogen nor potassium, such as calcium acid phosphate, and find that it brings about an increase in crop yields, we may be sure that the soil is needing phosphorus. Or if we try one *containing potassium* but neither nitrogen nor phosphorus, as for example potassium chloride (or muriate), and secure the same result, it is good evidence that the soil is in need of potassium.

Your state experiment station is able to make an analysis of any soil you may send to it, determining exactly how much nitrogen, phosphorus and potassium it contains. However, this analysis shows the total amount of these elements present, rather than the amount that is actually in a form that plants can use as food; and for this reason it is of no great value. In fact, actual field tests made after the plan suggested above are far more reliable in their results.

8. How the Fertility May Be Restored. Perhaps the most important phase of the entire problem of fertility is that of how to make soils, which have become infertile, fertile again. It merits the fullest discussion especially if this discussion includes a recapitulation and review of those facts and principles already learned.

(a) RESTORING HUMUS. Let us suppose that in the examination of a given field we have found it to be deficient in humus. Ask the class to give as many practical methods as possible of increasing the humus supply so that this cause of infertility may be removed. This may require considerable thought. However, it will be obvious that the only way to augment the humus supply is to add vegetable matter, by the decay of which more humus may be formed. This, of course, may be done in many ways; and it becomes merely a question of what ones are most convenient and practicable. The discussion should be guided in such a manner as to bring out at least the four methods given below:

(1) Straw, cornstalks, or other similar materials may be plowed under.

(2) Barnyard manure may be scattered and worked into the soil with a plow or disc.

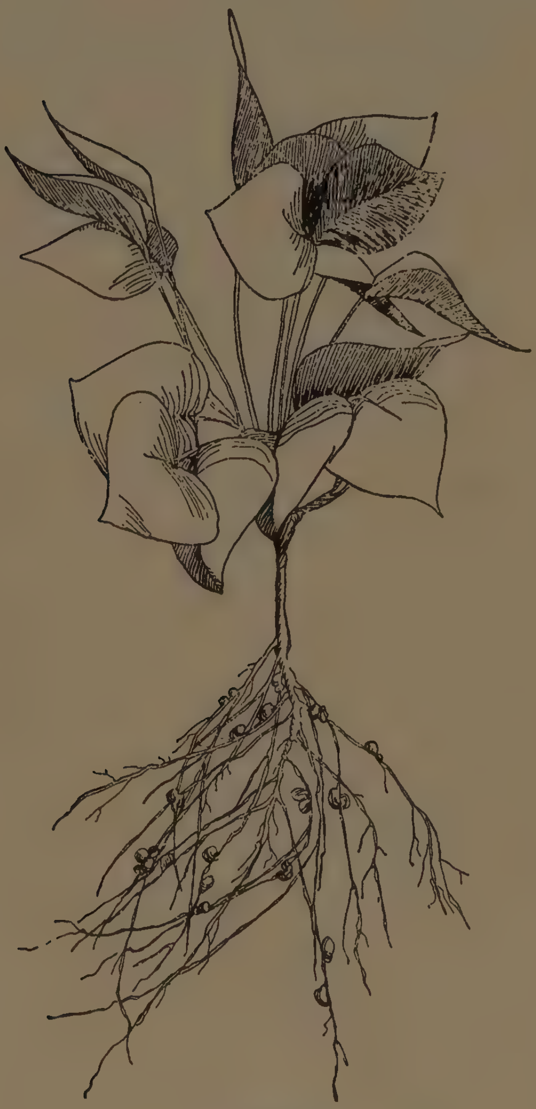
(3) Some crop like clover, cowpeas or rape may be plowed under while still green. A crop used in this way is called a green manure.

(4) The land may be given over to pasture or meadow grasses for two or more years. This method is highly effective because the numerous fibrous roots of the grasses leave an abundance of humus in the soil.

(b) RESTORING NITROGEN. If the field has been tested and found to be deficient in nitrogen, the problem of restoring the fertility must be solved in a manner altogether different from that above. The children will probably be unable to work it out without some help, though their reasoning will be that to increase the amount of nitrogen in the soil, something must be added to it which contains nitrogen. It is for them then to decide what particular materials could be used for this purpose. They will recall that Chili saltpeter was used in the field test because it contained nitrogen. Hence their conclusion will be that this could also be used to fertilize any land needing nitrogen. In this they will be right; but their attention should be called to the fact that there are several other commercial fertilizers that might be used instead.

Some one in the class may know or think that barnyard manure also contains nitrogen. This, too, is correct; and so this may be put down as the second method of restoring nitrogen to the soil.

It is hardly probable that any of the class will know that the bacteria which live on the roots of legumes, such as clover, alfalfa, or peas, really take nitrogen from the air and furnish it to the plants in a form which they can use. Perhaps they do not even know anything about the strange little colonies of bacteria which live on the roots of these plants. If not, they should be asked to dig up carefully and bring to school clover roots having these small bead-



COWPEA
The roots have tubercles containing nitrogen-gathering bacteria.

like bodies of various sizes attached to the fibers. Of course they will not be able to see the bacteria in these little bodies, which are called *nodules*; but the fact should be made clear that they are present in incredible numbers and that they really perform an exceedingly valuable work for us in restoring nitrogen to soils that are becoming exhausted of this element. The growing of legumes should then be put down as the third method of restoring nitrogen to the soil.

(c) RESTORING PHOSPHORUS AND POTASSIUM. In case the field tests have shown that the soil is deficient in phosphorus or potassium instead of nitrogen, either barnyard manure, which contains both of these elements, or commercial fertilizers may be used. It should be noted that there is no crop that will increase the amount of these elements in the soil as the legumes will increase the amount of nitrogen.

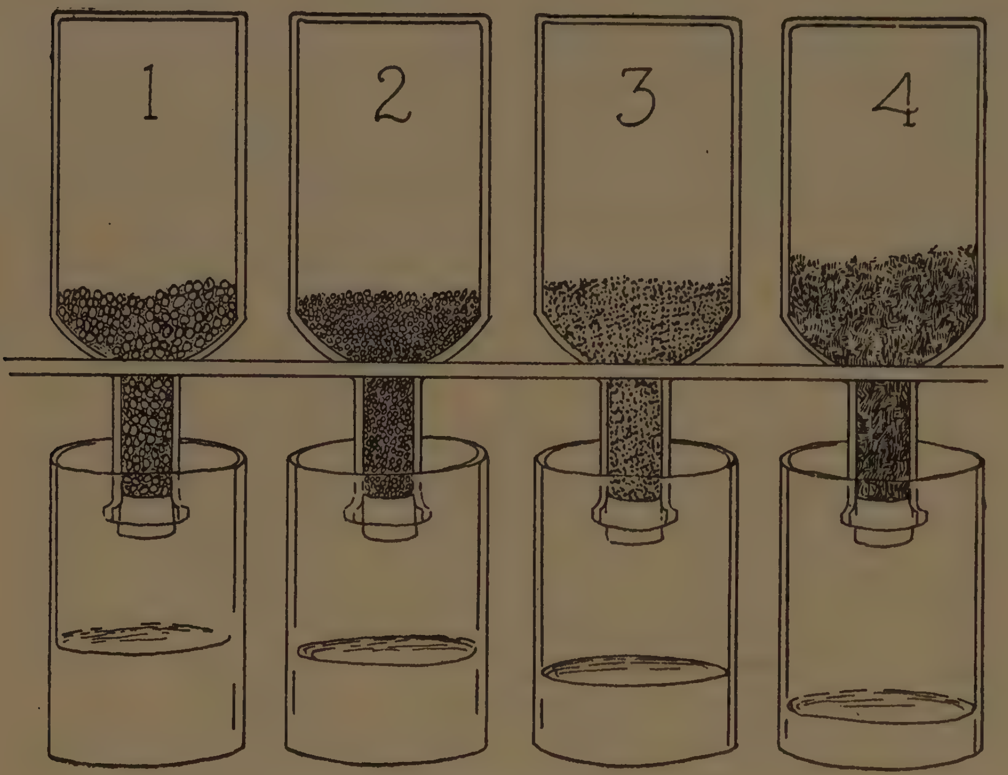
(d) CONSERVING MOISTURE. In our reasoning so far we have considered that if the store of humus in the soil is sufficient, there will be no difficulty as to the supply of moisture or air, since it was found by experiment that these are governed very largely by the amount of humus present. Suppose, however, that the amount of rain received during the growing season is hardly sufficient for crops. Evidently the soil in this case would become too dry whether it contained enough humus or not. Could this condition be remedied?

Allow the class to think over this problem very carefully. Some member will probably suggest that while we cannot bring down more rain, we might be able to use less. Follow this line of reasoning, then, for it leads to the consideration of a practice of the highest importance and value in seasons or regions of scant rainfall.

How can we use less moisture in growing crops?

The moisture, which the soil receives, escapes chiefly in two ways. Plants take up a part of it; but another part — and a very large one — simply evaporates from the surface of the ground without doing the crops any good whatever. Can this loss be prevented?

In answer, ask the class to fill two cans nearly full of moist soil, such as is found at a depth of six inches or more, and to cover the soil in one of the cans with about half an inch of very fine, dry dust. Set the cans in a sunny place for several days. It will then be found that the soil that is covered with the layer of dust is still moist, while that in the other can has lost most of its moisture by evaporation and is quite dry. This shows clearly the principle of the *dust mulch*, which is so much used in dry farming regions. A surface layer of dust is maintained; and so the crops get the moisture which would otherwise evaporate from the ground.



WATER RETAINED BY SOILS

This apparatus is easily made. All that is required is four bottles of the same size with large mouths, a board rack and four fruit jars. Place the same quantity of soil and of water in each bottle. The water in each jar shows the proportion drained out.

1. Gravel.
2. Sand.
3. Barren Soil.
4. Loam.

(e) IRRIGATION. Present next the problem of those regions which receive practically no rainfall at all so that not even the dust mulch will avail to provide plants with sufficient moisture. The plan of irrigating crops with water from rivers or artesian wells will be developed in the discussion; and if the account of how some given district has been reclaimed from the desert by one of the great irrigation projects of the government can be read or told, it will prove vastly more interesting and instructive than would the same account at another time. (See type study *Irrigation*, page 176.)

(f) DRAINAGE. Turn the attention now to the question of what can be done in case the soil contains not too little but too much water, as in the case of a swamp or bog. Here, of course, the discussion will relate to tile drainage, which merits careful study. Bring out in particular the three reasons below why crops cannot thrive in soil in which water is standing:

(1) The water excludes the air which the roots of plants must have.

(2) The water makes the ground too cold for plants to do well in it.

(3) The roots of plants do not, as we shall see later, take moisture from water *standing in the soil* at all, but only from the thin film which envelopes each soil particle. Hence standing water in the soil is a great detriment rather than a benefit to plants.

There are a few plants whose roots are able to take the oxygen which they need from that which is dissolved in the water, itself. The most important of these is rice, the cultivation of which is discussed on page 57.

9. Why We Till the Soil. All of the important reasons for the tillage, or cultivation, of the land should be deduced by the children from what they already know, though one or two may require considerable thought.

When the list is complete, it will show that we till the soil:

(1) To destroy weeds, as in the cultivation of the corn crop.

(2) To work plant material into the land, as when straw or green manure is plowed under.

(3) To loosen the soil and make it mellow so that water and air can enter it freely.

(4) To make a dust mulch, thus preventing the escape of moisture by evaporation.

(5) To expose different rock material from time to time to the action of the air, the sun, or the frost, so that the particles will become constantly finer; that is, to improve the texture of the soil.

(6) To break up clods and pulverize such soil as has become baked and hard so that plant roots can penetrate it more easily.

10. How We Till the Soil. In discussing the tillage of the soil to destroy weeds, the question should be asked as to when weeds are most easily killed — that is, at what stage of their growth. Lead the children to see that at the time the little plant has used all the food contained in the seed from which it grew, but before it has put forth leaves to manufacture more food for itself, it is most easily destroyed. This is at just about the time it is coming through the ground. Experienced farmers have this in mind when they say, "Kill weeds in the white stage."

It follows then that the harrow is the most effective of all weed-killing implements if used at the right time. If, however, the weeds are allowed to get a start, the disc or the cultivator will evidently be needed to destroy them.

What implement should be used to work plant material into the soil? The class will probably agree that it should be the plow; but if some member should suggest that in many cases the disc should be used before the plow, accept this as the better answer. Then show that in case a large amount of plant material is plowed under without being first chopped fine by the disc, a layer is formed which prevents the moisture from below from rising to the plant roots.

In general, the implement to be used is determined by the end that we are trying to accomplish. Thus to loosen the soil to admit water and air, we should use the plow or disc; to make a dust mulch, we should make use of the harrow or perhaps a fine tooth cultivator; to improve the texture of the soil by bringing new rock material to the surface, the plow is commonly used; and clods may be broken up by the disc, the harrow, or the plow.

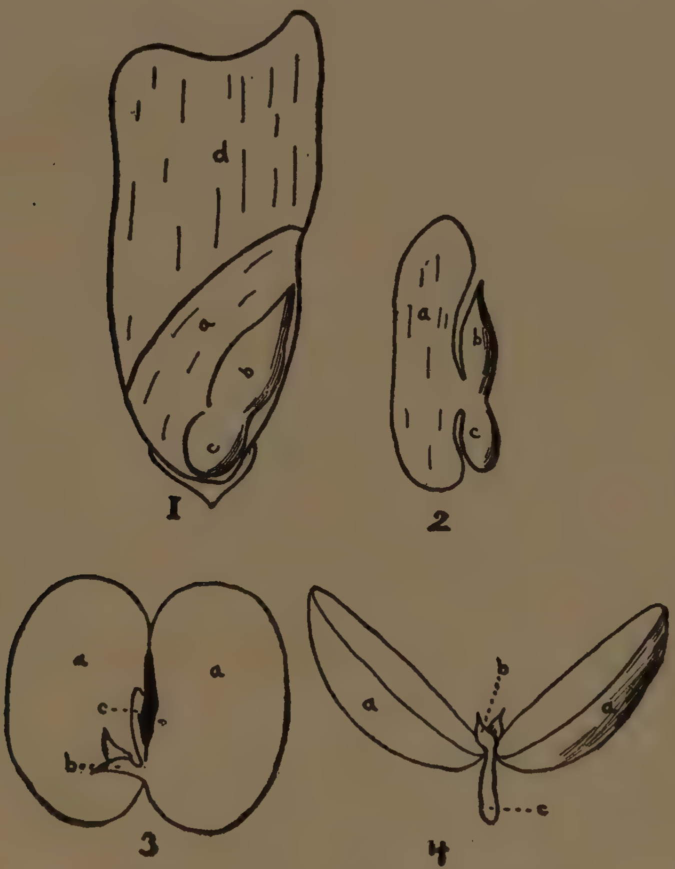
TEST QUESTIONS

1. Why are there more people to the square mile in the States bordering on the Mississippi River than in the Rocky Mountain States?
2. What other regions of the world are densely populated? Why?
3. How can you prove that soil contains vegetable matter?
4. What is loam?
5. In what ways has the atmosphere aided in the formation of soil?
6. Show how plants and animals aid in the formation of soil. Can you find any evidences of their work about your home?
7. What are bacteria? How do they assist in fertilizing the soil?
8. How do you account for the deep rich soil along the banks and near the mouths of rivers?
9. How may we find the needs of soil when it becomes infertile?
10. Mention three ways of restoring fertility to the soil.

CHAPTER TWO

THE ROUND OF PLANT LIFE

1. The Seed. Before taking up the study of farm crops, it is important to find out something about how plants grow, and how it is possible for them to take the minerals and water from the earth and gases from the air and combine them in forms which become the foods of all other living creatures. This work may properly begin with the study of seeds.



EMBRYOS OF CORN AND BEAN
1 and 2, corn.
3 and 4, bean.
a, cotyledons.
b, plumules.
c, the radicle or root stem.
d, outer seed covering.

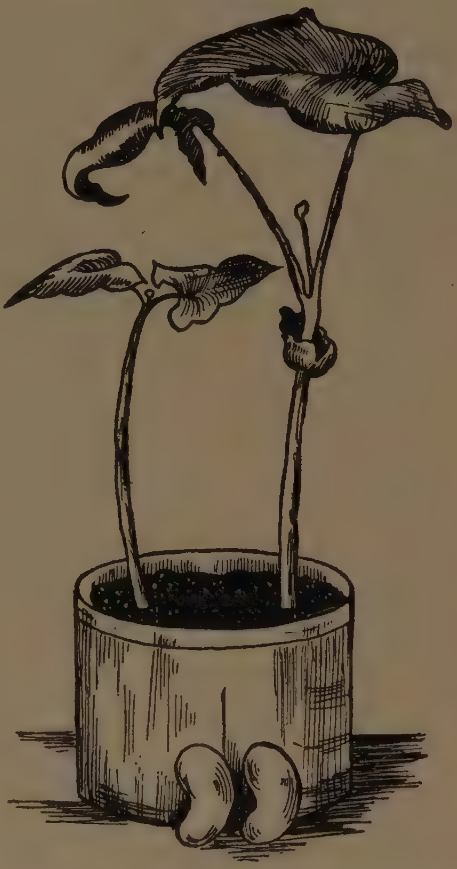
Let the children prepare the way by giving their ideas as to what seeds really are. All will hold the opinion that the germination of the seed is the beginning point in the life of the plant.

(a) EMBRYO. Show them that they are mistaken in this by having them open some seeds of different kinds and find in each one the tiny plant which is tucked away there, and which is already alive just as truly as it will be after it has put forth leaves or flowers. This little plant, which is called the *embryo*, may be easily found in the corn and bean. It exists, of course, in every seed—even in those which are so small that we can hardly see them; so the embryo should be put down as the first one of the three very important parts of every seed.

(b) FOOD SUPPLY. The second important part of the seed is the *food supply.* Ask the class to try to find it in the corn and bean with which they are working. In the corn it makes up the entire kernel, except the germ and the seed coat, while in the bean it forms the two halves which split apart naturally when we remove the seed coat. In fact these two halves may be regarded as leaves of the little plant within the seed, since they are attached to it just as leaves would be; but they are enormously swollen or gorged with food ready to be given up to the little plant after the seed germinates.

Why do the embryos need a supply of food? They do not need it until they begin to grow; but then, like boys and girls who are growing, they must have food or they will starve.

Experiment. To show that this is true, have the children plant a number of beans in a box in the schoolroom. As they come through the ground, it will be seen that the two halves of each seed, which contain the food supply, are being pushed up into the air. Cut these away from some of the plants as soon as it can be done without cutting off the stems or growing tips. Then watch them day by day to see how



Effect of robbing infant plant life of its stored food. The cotyledons have been removed from the seed of the plant at the left.

they are affected by being robbed in this way of their food supply. They will become stunted and dwarfed, while those not treated in this manner will continue to grow sturdily. After this the class will readily agree that the food supply, like the embryo, is a very essential part of the seed.

(c) SEED COAT. The third important part of the seed is the *seed coat.* Draw out the fact that the embryo, which is very tiny and delicate, cannot be expected to prove able to withstand exposure or the attacks of enemies. Molds would grow into it and destroy it; or if it absorbed moisture, freezing would kill it. Hence it must have protection, and it is to furnish this that the seed coat has been provided by Nature.

2. How We Select Seed for Planting. Why should we be careful to select good seed for planting? Let the class suggest as many reasons as they are able to think of in answer to this question. This will lead to a discussion of how we can tell whether any given seed is good or poor. Bring out an ear of corn and ask the class to decide whether it would be a good one for seed, stating reasons for their conclusion. It will be judged merely by its appearance, of course, since the children will have no other evidence upon which to base a conclusion. They should not be expected to show expert judgment in this; but after they have made their decision, some such questions as the following should be asked:

In case we use the ear for seed, will the corn which grows from it probably mature early or late?

Will the ears probably be attached to the stalks at the proper height or will they be too high or too low instead?

Will they be easy or hard to husk?

Will all of the stalks produce ears, or will some of them probably be barren?

These questions are really very important to the people who grow corn; yet they cannot be answered at all from a mere inspection of the ear. This makes it plain that in the selection of seed it is not enough that we see the seed itself. Rather, we should also see the parent plant from which it came. We would expect this ear, for example, to yield early-maturing corn *provided* the parent plant matured its seed early. The ears would be borne at about the same height and they would be about as difficult to husk as on the parent plant. If there were many barren stalks in the field near the parent plant, we may be certain that pollen from them has fertilized some of the kernels on this ear, and that a part of the plants which they produce will as a result prove barren.

3. Results of Seed Selection. When the white man first came to America, he found the Indians raising corn; but it did not much resemble that which the people of the United States are growing today. The yield was poor, the ears small, and the kernels exceedingly shallow and flinty. In fact there are few farmers who would not be ashamed to raise such corn at present. Ask the class to account for the great difference between the corn of the Indians and that which we raise today. With a little help, they should reach the conclusion that the great improvement in this crop is simply the result of seed selection, such as we have discussed above. The white man has chosen the best ears for seed for many centuries; and since a seed ear will almost invariably produce some ears better than itself, as well as some that are poorer, it follows that the best will constantly become better. The children should understand that nearly all other crops that we grow differ from the wild plants from which they originated, merely because of our practice of selecting the best for seed.

4. Germination of Seeds. Place before the class a number of seeds of any kind and ask just what conditions must be provided in order to cause them to germinate.

Some will think that they will have to be planted in the ground. Inquire then as to whether it is really necessary to put seeds in the ground in order to cause them to begin to grow.

If there is a disagreement, suggest that these seeds be wrapped in a wet cloth and put in a warm place for two or three days. If the cloth has been kept moist, they will then be found to have germinated quite as well as if they had been in the earth.

(a) MOISTURE. The class will conclude then that the soil really has little or nothing to do with the germination of seeds. How then is it brought about? When they have thought it over, they will probably decide that moisture is one of the necessary conditions. If they are not sure about this, have them try to cause some seeds to germinate in dry dust.

(b) SUITABLE TEMPERATURE. They will probably conclude also that a suitable temperature must exist — which accounts for the fact that the innumerable seeds which lie in the ground throughout the winter germinate as soon as the warm weather comes.

(c) OXYGEN. The third and last necessary condition of germination, the children may not be able to discover for themselves. *Oxygen* must be present; but it is difficult to show this satisfactorily. If an air pump is available, the test may be made by wrapping some seeds in a wet cloth, placing them under the bell jar, exhausting the air, and allowing them to remain there for three or four days. It will then be found that no germination has occurred. If this experiment cannot be made, the necessity for oxygen may be shown in another way. Have two samples of soil brought to school, one of which is nearly pure clay and very sticky when wet, while the other contains much humus and is therefore very mellow and porous. Ask the class through which sample the air — which of course contains oxygen — can circulate more freely. They will promptly decide that it can circulate quite freely through the porous sample, while it is doubtful whether it can pass through the other at all. Now put each sample in a can, moisten them with the same amount of water, plant seeds in them at the same depth and place them side by side in a warm place for several days. It will then be found that the seeds in the porous soil have germinated promptly and grown rapidly, while those in the clay have germinated very slowly and have hardly grown at all.

(d) PLANTING. When the three essential conditions of germination have been made clear, ask at what depth seeds in general should be planted in the ground, for the class should then be able to reason out the rule that is followed as to the depth of planting practically all seeds. The temperature of the soil does not vary enough in the upper two or three inches to be given much consideration. However, the amount of moisture is least at the surface and increases with depth, while the supply of oxygen is greatest at the surface and decreases with depth. The seed must have moisture; but in order that it receive sufficient oxygen, it should be near the surface. The rule which grows out of this, then, is *to plant the seed at the least depth at which it can find sufficient moisture.*

5. How the Little Plant Becomes Self-Supporting. One of the facts which we must keep in mind about plants is that they need food just as do animals. We have found that in every seed is a store of food provided for the infant plant while it is becoming established. However, we know that this store is really not large; and we have probably wondered just how long it is supposed to last the little plant, and how the latter procures its food after this store is exhausted.

Nature's plan is that the infant plant shall have begun *making its own food* by the time the supply in the seed has been consumed. How does it do this? Food is made in the green leaves. Indeed we may say that every green leaf is a factory for making food. As soon then as the little plant gets one or more green leaves, it becomes independent of the food supply in the seed; but if it should happen instead that the store of food in the seed is exhausted before the plantlet has succeded in putting forth any green leaves, then it must die from starvation.

The appearance of the green color is a true sign by which we know that the infant plant has become self-supporting; and this green color begins to appear as soon as the stem sprout reaches the light. This may be shown in an interesting manner as follows:

Experiment 1. A few beans or kernels of corn or other grain are planted in some moist earth in a can, which is then so tightly covered that no light whatever can enter. It is set in a warm place and within a few days the stem sprouts will have emerged from the ground. After this, as long as the light is completely excluded from them, they will remain white; but if we remove the cover, the green color will quickly appear.

From the foregoing it is clear that the life of the little plant depends in every case upon whether the stem sprout can reach the light and put forth green leaves before the food supply in the seed has become exhausted. This is the "race of life and death" which every infant plant must make. Ask the children here why we should be careful not to plant seeds too deep. The answer should be that if a seed is buried too deep the food supply will not last until the young plant has put forth green leaves, and so it will lose its race for life.

By this time it will have become clear to the class that it is a matter of vital importance to the little plant that the stem sprout reach the light in the *shortest possible time*; and to do this, it is necessary that it grow straight toward the light from the beginning. Inquire how it happens that it always grows in the right direction. Though it has no knowledge of direction, it always grows upward; but while the children, and likewise the rest of us, may puzzle over it, no one can explain it. Let them demonstrate that it is true by the experiment below:

Experiment 2. Fill a cigar box level full (packed down) with moist earth, scatter several grains of corn on the surface, lay a piece of glass upon them so that it presses them into the soil, and fasten it firmly in place by wrapping a cord about it. Now set the box upon one edge so that the glass forms a vertical but transparent side wall through which the germination of the seeds may be watched. It will be observed that no matter how the seeds may be lying, the stem sprouts, as soon as they have burst through the seed coats, turn and grow upward. After they have become about two inches in length, turn the box over so that the stem sprouts are pointing down. They will promptly turn, doubling back upon themselves, and *grow upward.*

STEM SPROUTS DOUBLING UPON THEMSELVES

6. Work of Leaves. (a) MANUFACTURE OF CHLOROPHYLL. There are many facts about plants, which, like the one just noted, are at once wonderful and inexplicable. One of these is the formation of the green coloring matter, which is called *chlorophyll*, as soon as the stem sprout reaches the light. An interesting discussion will follow the question as to what would be the result if anything should go wrong with the laws or processes of Nature so that chlorophyll could no longer be formed. Plants could then manufacture no food for themselves and would inevitably perish; and this of course would cause all animal life, including ourselves, to vanish from the earth.

(b) Manufacture of Starch. Understanding this, the children will be interested in knowing more about the manufacture of food in plant leaves. The subject cannot be studied in much detail for it requires a knowledge of chemistry. However, the class should be told that this work of foodmaking requires not only chlorophyll but sunlight as well, and that the chief food produced by the leaves of practically *all* plants is ordinary starch, with which they are probably perfectly familiar. It may surprise them to know that about three-fourths of all their own food is really starch, which comprises the greater part of the bread, potatoes, and all other cereal or vegetable foods that we use.

The great work of plant leaves, then, is the manufacture of starch. Suggest to the class that they find out for themselves whether this is true, in the following manner:

Experiment. From an ordinary cork two round discs should be cut with a sharp knife, and these should be fastened to a leaf of a growing plant by putting one on each side and thrusting a pin through both discs as well as the leaf between them. The discs should be pressed closely against the leaf, since they are intended to keep the sunlight away from it. Any plant may be used, whether it be growing out-of-doors or in the house, provided the sun is shining upon it. At the end of two or three hours, cut the leaf from the plant, remove the cork discs, dip it into boiling water for a moment and then into denatured alcohol until all of the chlorophyll is dissolved out of it, for alcohol dissolves chlorophyll readily. The next step is to test the leaf to determine if starch is present in it. This test is very simply made. If a little tincture of iodine, which may be purchased at any drug store, is poured upon the leaf, the latter will turn blue if it contains starch, for iodine causes starch to become blue. When the test is made upon this leaf, a striking fact is disclosed. The leaf turns blue except in the round space from which the sunlight was excluded by the cork discs. Allow the class to interpret the result. If they reason well, they will decide that the work of starchmaking has been going on in that part of the leaf which was exposed to the sun, that it had not been going on in that part from which the sunlight had been excluded, and that such starch as might have been present in the latter space before the experiment began had been carried away while it was in progress.

The last fact suggests an inquiry as to what becomes of the starch that is made in the leaves of plants. A part of it is carried to other parts of the plant where, as we have seen, it is used as food; a part of it is stored by certain plants in the roots, stems or leaves; but most of it is stored in the seeds for the use of the infant plants while they are trying to make a start in life.

7. Work of Roots. Thus far we have followed the growth of the plant from the seed upward to the green leaves which supply it with food; but we must not forget that while the stem sprout is pushing upward and while the green leaves are being formed, the root is also developing below the surface of the ground.

We have found that the leaves of plants have a definite work to do. Is the same true of the roots, and if so, what is the nature of this work?

The class may at first be puzzled over this; but they will remember from a preceding section that plants must have moisture and certain food elements from the soil, and that the latter also provides for them the necessary foothold. From this they should reach the twofold conclusion below as regards the work of roots:

(1) They anchor the plant firmly in place.

(2) They take moisture and food elements from the soil, passing them upward to the parts above.

The roots of plants are hidden from our sight.

8. Root Systems. Inquiry will probably bring out the fact that the children do not know very much about them. They should be asked to dig up and bring to school a plant of some small grain or grass, as wheat or timothy, also a clover or bean plant.

The two plants, of course, differ greatly in appearance above the ground, but after the dirt has been washed from the roots it will be discovered that the difference does not end there. The long, slender leaf of the grass or wheat with its parallel veins, and the shorter, broader leaf of the clover or bean with its netlike system of veins, are plainly made after all-over patterns; yet, if it is possible, the differences between the root systems are even greater than those between the leaves.

Have the class examine the clover or bean root first. They will find that it really consists of a main central root growing downward and having a number of lateral branches. The grass plant, on the other hand, has no central or main root at all, but a bundle of dozens or perhaps even hundreds of threadlike fibers, all of which seem to spread from a single point at the base of the stems just below the surface of the ground.

9. Great Classes of Plants. All the crops that farmers raise belong to one of these two classes of plants; that is, they are either broad-leaf plants, which are also called *dicotyledons*, or grass plants, otherwise known as *monocotyledons*. Have the class name as many of the broad-leaf plants as possible. The list will include the clovers, cotton, practically all garden vegetables, and all fruit trees and shrubs. It should be made clear that these plants all have roots similar to that of the clover or bean plant which is before them.

Ask them for a similar list of the grass plants. The children may be surprised when they find it necessary to list here nearly all of the really important crops, such as wheat, corn — which is really a giant grass — barley, oats, rice and all of the pasture and meadow grasses.

We have noted that the masses of fibrous roots of the grass plants all seem to grow out from a single point just below the surface of the ground. It is a curious but interesting fact that we cannot influence the depth of these roots even in the slightest degree by planting the seed at different depths. This is really a serious matter with farmers in regions of scant rainfall, for they greatly desire their corn, Kafir corn, feterita and millo maize plants to have deep root systems, since there is more moisture at greater depths. While they are not able to accomplish this by deep planting, they are able to do it otherwise. Give the class a chance to think how it can be done. The answer is that the corn or other similar crop is planted in the bottom of a furrow where the little plants take root, and *after the root systems have formed*, the furrow is gradually filled up by means of a disc or shovel cultivator. This plan of planting seed in the bottom of furrows is known as *listing*.

10. What the Stems Do. We have studied now the leaves and roots. Let us turn our attention next to the stems, which join these two important parts of the plant.

Have the children discuss the functions of stems. There are three which are of great importance, but of these it is probable that the class will be able to think of only two. They will agree (1) that an important function of the stem is to hold the green leaves up to the sunlight, without which they could manufacture no food; and (2) that they perform another important work in conducting the water, which contains the food elements taken from the soil, upward to the leaves. If they are unable to give others, the third should be brought out by suggestive questions.

What, for example, becomes of the food which is manufactured in the leaves? The class will remember that it is this food which makes the growth of the plant possible. But what parts of the plant grow? All parts grow; and this is as true of the roots as of the parts above the ground. Does it not follow then that the stems must conduct the food from the leaves to other parts of the plant, just as they conduct the water from the roots to the leaves? This is the third important function of stems.

Explain to the class that in the case of trees and other plants which have woody stems, the inner part of the bark conducts the food downward from the leaves, while the sap from the roots is conducted upward by the wood beneath the bark. What, then, would be the result of removing a few inches of bark clear around the trunk of a tree? The decision as finally reached by the class should be not only that the tree would die, but that this would be due to the starvation of the roots, since the food could not pass downward. By girdling trees in this way, the pioneer settlers made their first clearings in the forest; and by girdling our

TREES KILLED BY GIRDLING
The tree at the left has been girdled; that at the right has not.

fruit trees in winter, rabbits cause a great many of them to die. An experiment to show the effect of girdling may be made as well with a small shrub, such as a wild rose or a currant bush, as with a large tree.

11. Classes of Stems. Are all stems alike? If not, in what respects do they differ? These questions should bring out the fact that the grass plants and the broad-leaf plants differ as greatly in their stems as they do in their leaves and roots. The peculiarity of the stems of the grasses, particularly of the small grains, in that they are hollow and also jointed (the latter preventing the collapse of the thin walls) should be discussed carefully. The fact that the stem is stronger when in the form of a hollow cylinder than it would be if the same amount of material were in the form of a solid rod, should be made clear; but it should be noted that in the case of very large grasses, such as the corn plant, Nature finds it necessary to strengthen the hollow stems still further by filling them with pith, which prevents the collapse of the walls between the joints.

12. Flowers and Their Work. To many people, and to children in particular, the chief use or value of flowers seems to lie in their beauty and fragrance. It is necessary to emphasize the fact that flowers really perform a far more important work than this in the economy of Nature.

Inquire if all plants have flowers. If some members of the class answer in the negative, ask them to name some plants that have none. It will probably be found that they do not know of the inconspicuous flowers of the grasses, and they may be surprised to learn that the small grains have flowers just as truly as do the clovers, or plants like the rose or lily. These flowers, however, are not bright-colored, nor are they fragrant; so we must conclude that the real work of flowers is not merely to satisfy our sense of beauty.

The fact should be brought out then that the great work of flowers is to produce seed from which other plants of the same kind may grow. How do they do this? In answering this question, a flower should be dissected to show that it consists of only two really essential parts; that is, the part which produces pollen, and the part which receives the pollen and produces the seed. The latter, which is at the center of the flower, is called the *pistil*; and the beginning of every seed dates from the time when a grain of pollen fell upon the pistil in which the seed was formed.

All flowers have the two essential parts named above. They may be found in the flowers of the wheat or of the timothy as readily as in the blossoms of the apple or strawberry. If possible, the flowers of some of the small grains should be examined so that the children may satisfy themselves that this is true.

A very peculiar flower is that of the corn plant. In some way the two essential parts of this flower have become separated from each other, and we actually find the pollen-producing part on the top of the stalk, while the pollen-receiving part, or pistil, is lower down on the plant. The former we call the tassel, while the latter becomes the ear. These two would have to be joined together to form a complete flower, such as we find on most other plants.

BEES IN A BLOSSOM

As the bee enters a blossom to gather honey, some of the pollen sticks to it. This the insect carries to another blossom, where some of it is deposited on the pistil as the bee extracts the honey from the flower cup.

One curious rule of the plant kingdom is that in order to produce seeds of strong vitality, the pollen received by any pistil should not come from the same flower, nor even from any other flower on the same plant, but from *another* *plant* of the same kind. While there are some exceptions, this rule holds very generally.

A natural inquiry then, is, "How may pollen be carried from the flower producing it to another on a different plant?" The class may think of the wind as an agent in this work, but they may not know of the very important work of bees and other insects in carrying pollen as they gather honey. When this has been made clear, it will be in order to ask them to account for the fact that some flowers are showy and fragrant, while others are so inconspicuous as to escape our notice altogether. Their answer should be that the fragrant and bright-colored flowers are those which depend upon insects to carry their pollen, while the inconspicuous ones are those which depend upon the wind. In this they will be precisely right; and it follows that the flowers whose delicate colors and delicious fragrance delight us so greatly were made beautiful and fragrant, not to please us, but to please and attract the insects that help them to carry on the great work for which they were created.

TEST QUESTIONS

1. What are the parts of a seed? Can you show them to your pupils?
2. Why is a food supply necessary to seed germination.
3. Why should you lead the pupils to perform as many experiments as possible in their study of agriculture?
4. What points should the former consider in selecting seed for planting?
5. What conditions are essential to the germination?
6. What are the functions of the leaf?
7. Does the corn have the same root system as clover?
8. Why will "girdling" a tree cause it to die?
9. How is pollen carried from one plant to another?
10. Can you find any plants besides corn that have one set of flowers bearing only stamens and another set bearing only pistils?

CHAPTER THREE

FARM CROPS

1. Why Plants Are Grown. The chief business of farmers is the growing of useful plants. If we ask whence these plants derive their usefulness to mankind, the discussion which follows will probably call for a more or less complete classification of all cultivated crops.

It will be decided that plants are usually grown only for certain parts which men have found desirable. Thus we raise a fruit tree only for the fruit which it bears rather than for the tree, itself, while the cotton plant is grown only for the lint attached to its seeds. The classification, then, should be made according to the parts for which the various crops are raised. With perhaps a little help, the children should be able to classify nearly all cultivated plants under the five heads below:

(1) Plants cultivated for their *grains*, such as corn, wheat, oats, rice, barley and rye.

(2) Plants cultivated for *forage* and *pasture* for animals, which eat the leaves and stems. These plants include such grasses as timothy, blue grass, Bermuda grass and some others, and also the very important class of plants known as legumes, among which are alfalfa and the clovers.

(3) Plants grown for the *fiber* which they produce. Among these are cotton, flax and hemp.

(4) Plants grown for their *fruits*. These include the tree fruits, such as apples, pears and peaches; the small fruits, as strawberries and blackberries; and also grapes.

(5) *Garden vegetables*, or truck crops.

CORN

2. Importance. Among the plants which are grown for their grains, Indian corn is preëminent in the United States. This plant, however, is not a native of our own country at all. It has come to us from southern Mexico and hence is to be regarded as a tropical plant by nature; yet it is at present the leading crop in a number of States in the *north central part* of our country and is even yet pushing its way still further northward.

3. Why Corn Has Moved Northward. Ask the class if they can account for this northward march of the corn plant from Mexico through our own country.

The part which Nature might have played may be passed over lightly since corn does not grow in a wild state outside of its native home. Have the children instead try to find the answer in the methods used by men in growing the crop in its adopted home. If they are unable to discover the explanation, lead the discussion into the question of the probable effect of selecting for seed those ears *which mature earliest.*

As this is discussed, it should become apparent that the practice would tend to develop a type of corn capable of maturing in a shorter period of time, and that if the practice were continued, the time required by the crop to grow and mature would become gradually less. Inquire, then, as to whether this change would or would not make the crop capable of growing and maturing in other localities farther north. Obviously, the shorter the time required by any crop to mature its seed the farther north it can be grown; and so the migration of corn northward becomes the logical result of selecting seed for early maturity — a practice which has always been general, particularly near the northern borders of the corn belt.

4. The Effects of Migration upon the Corn Plant. It is natural to suppose that in adapting itself to new and different climates, any plant would become changed in some respects. The chief difference between the climate of Mexico and that of the central part of the United States is in the length of the growing season. Just how would a shortening of the growing season probably affect the character of the corn plant? The class should reason that with a shorter time in which to manufacture food, the leaves of the plant could produce less and that this would mean that the plant and also the ear would probably be smaller than in regions having a long growing season. All this is true. The largest plants, the largest ears, and likewise the deepest kernels are all found in the South where the growing season is longest; and as we pass northward, the stalks and ears become gradually smaller and the kernels shallower.

5. The Successive Steps in Corn Growing. Let us turn now to the study of actual methods of growing corn. Ask that the class try to give in order the important steps which would be found necessary if they were to attempt to raise a corn crop. They may not succeed very well, but with an occasional suggestion they should finally get the successive steps listed about as below:

(1) The testing of the seed.

(2) The preparation of the seed bed.

(3) The planting of the seed.

(4) The cultivation of the crop.

(5) The selection, drying and storage of seed for another crop.

(6) The harvesting of the crop.

(a) THE TESTING OF THE SEED. Suppose that a farmer plants a field, using seed corn of which only eighty per cent is capable of germination, and that he secures a total yield of one thousand bushels. How many bushels does he lose by the use of poor seed?

A few simple problems of this description will emphasize the importance of this preliminary step in corn growing. Proceed from this to the consideration of actual methods of testing seed corn. In our study of seeds, we found three conditions that are necessary for germination. Review them again in class since they must be provided in every test of the germinating power of any kind of seed.

There are many methods of testing seed corn, though all rest upon the same four principles:

(1) The seed should be kept moist.

(2) It should be kept as nearly as possible at a uniform temperature of about seventy degrees, or about that of an ordinary living room.

(3) Oxygen must not be excluded.

(4) The spores of molds should be killed by boiling the cloth or any other material that touches the seed, as otherwise the molds are certain to injure or destroy its vitality.

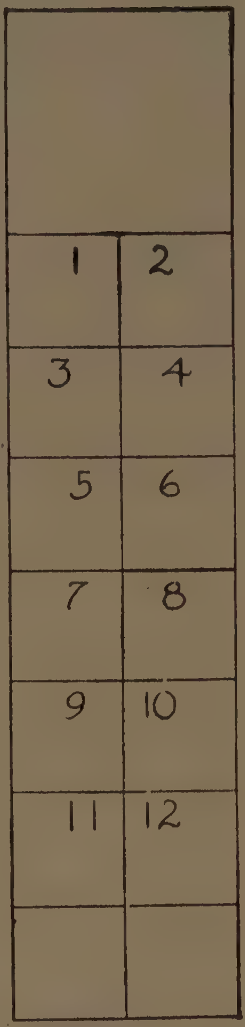
With these rules in mind, have the children test a number of ears by what is known as the *rag doll* method, which is in general use and is quite simple and reliable.

Each pupil should have a piece of muslin about a yard in length and nine inches wide. Unless it is new, this piece should be boiled before it is used in making the test.

With a lead pencil a line should be drawn lengthwise along the middle of the strip. Then by means of cross lines, four inches apart, the strip should be divided into approximate squares. There will be eighteen of these squares, but four at one end of the cloth and two at the other end will not be used. The remaining ones should be numbered from 1 to 12.

The twelve ears to be tested should be numbered by placing a small rubber band about each one and fastening to the band a numbered tag.

The strip should be wet and laid upon a desk or table. Six kernels should then be taken from ear number one and laid with germs upward upon square number one. Two of these kernels should be taken from opposite sides near the tip, two from opposite sides near the middle, and two from opposite sides near the butt; but no two kernels should be taken from the same row.



“RAG DOLL”

Kernels should be taken in the same way from ear number two and laid upon square number two, and so on until each square contains six kernels taken from the ear of the same number.

A small stick should now be laid across the end where the four vacant squares were left and the cloth rolled loosely about it until all the kernels are inclosed. The stick should be removed, a string tied *loosely* about each end of the "rag doll," and it should be placed in a pail of water for eight or ten hours. When it is removed, the strings are cut away from the ends so that oxygen may enter, and the rag doll is wrapped loosely in a moist gunny sack or other coarse cloth and left where the temperature will be about that of an ordinary living room, for five or six days, during which time it must not be allowed to dry out. At the end of the time stated, the strip should be carefully unrolled and the kernels examined. A kernel is considered strong only in case *both* stem sprout and root sprout are strong; if either is weak, the kernel is regarded as weak; and if either is missing, or if the kernel has not germinated at all, it is regarded as dead.

To be regarded as good, a seed ear should show by this test no dead kernels and not more than one that is weak; and many of the most careful farmers reject an ear unless all kernels prove strong.

(b) THE PREPARATION OF THE SEED BED. By the term *seed bed*, we simply mean the ground in which the seed is to be planted.

The character of the seed bed for corn is determined largely by the peculiarities of the corn plant; and in case the members of the class are familiar with the crop, they should have little difficulty in determining what the characteristics of the seed bed should be.

Taking these up one by one, call attention to the fact that the corn kernel is large and consequently must absorb an unusual amount of moisture during germination. Ask what condition of a well-drained seed bed would enable the kernels to absorb a large amount of moisture from the soil about them. The answer should be that if many small soil particles are in contact with the germinating seed, the latter will be able to absorb a greater amount of moisture than if only a few large particles were in contact with it. This means of course that the seed bed should be *finely pulverized.*

Next call attention to the fact that one of the chief differences between the corn plant and others lies in its amazing rate of growth during the summer months. What does this characteristic of the plant require as to the conditions that must be provided in the seed bed? The twofold answer is that in order to make rapid growth possible, the seed bed must contain an abundance of *available plant food,* which, as we have previously seen, depends largely upon the amount of humus in it, and also that in order that the roots may grow through the soil with sufficient rapidity to absorb food elements as fast as they are needed by the plant, the seed bed must be *loose and mellow.* And finally, to the three seed bed conditions already brought out, a fourth should be added. Since the seed is planted and the crop taken care of by machinery, it is necessary that the surface of the seed bed be *smooth.*

Inquire now how the four seed bed conditions named above may actually be brought about. The discussion should be so directed as to bring out the following points:

(1) To break the soil apart and make it loose and mellow to a considerable depth, the plow should be used.

(2) To pulverize the soil properly, the disc and harrow are the most useful implements.

(3) To make the surface of the seed bed smooth, it is usually necessary to harrow the field repeatedly.

(c) PLANTING THE CORN. Introduce this topic with a question as to when corn should be planted. Of course no arbitrary date can be given; but the point should be made clearly that, owing to its tropical character, we cannot expect this crop to withstand frost or the cold, chilly weather of early spring. This explains why it is necessary to plant corn much later than other cereals, such as wheat, oats, or barley; and it also explains why farmers cannot be guided by the calendar as to the proper time to begin corn planting. Instead, they must be guided by the thermometer. Not until the ground has become warm, may the seed be safely planted. Ask now if it would be a good plan for a farmer to wait a few days, or perhaps two or three weeks, after the ground has become warm in order to make sure that cold weather will not return and injure the crop. The experience of the great majority of farmers in the past shows that this plan is a mistake in most parts of the corn belt, since it reduces the length of the growing season and greatly increases the danger of injury from early fall frosts.

Take up now the actual methods of planting corn, of which there are three in general use. Most of the class will know of the practice of *checking*; *i.e.*, planting the corn in hills so that it forms rows either lengthwise or crosswise. Compare this method with that of *drilling*, in which the corn is planted in a continuous row so that the kernels are only a few inches apart. The first plan has the important advantage that the crop can be cultivated in both directions so that the growth of weeds can be controlled much more easily, and this doubtless accounts for the fact that it is in general favor. However, if the field is irregular in shape so that checking is difficult, or if the corn is to be used as silage, drilling is often preferred. In the latter case, by planting the seed close together, the stems are made less coarse and woody and so more desirable as a feed for animals.

The third method of planting corn is *listing*; it has already been explained under the study of the root systems of the grass plants; but it should be carefully reviewed again at this point as our study of the cultivation of the crop, which is soon to follow, will require an accurate knowledge as to the character of the root system of the corn plant.

(d) THE CULTIVATION OF THE CROP. Before taking up this subject, have the class recall the six objects, or purposes, of tillage, as they were brought out in the latter part of our study of soils and tillage. Ask, then, what ones of these six objects the farmer has in mind when he cultivates his crop of corn. It will be decided that there are at least four reasons for the cultivation of the crop. These are:

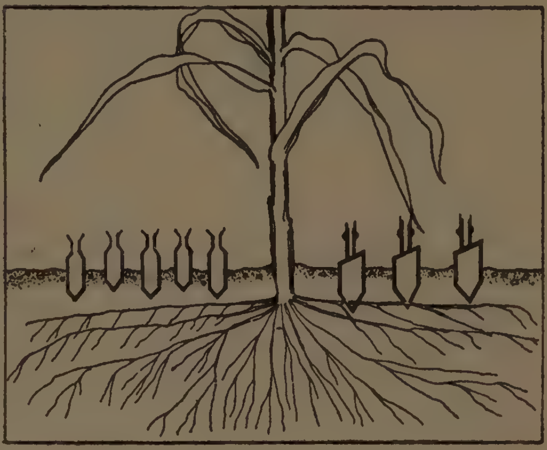
(1) To destroy weeds.

(2) To make the soil loose and mellow, so that water and air may enter freely.

(3) To make a dust mulch, thus conserving moisture.

(4) To break up clods and pulverize soil that has become baked, so that roots may penetrate it easily.

The discussion then should turn to the best methods of accomplishing these purposes. We have already learned that the most efficient of all implements for destroying weeds is the harrow, provided it is used while the weeds are in the white stage; and so *harrowing* may be put down as the first important operation in the cultivation. It is performed either before the corn has reached the surface or while it is still very small.



CULTIVATION OF CORN
After the roots have developed cultivators with small shovels should be used, otherwise the roots will be injured.

After the harrow, the *cultivator* is used. Inquire as to whether large or small shovels should be used in this work. The class may decide that since large shovels will break and loosen the soil to greater depths, it would be better to use them than to use small ones. Raise the question then as to whether the size of the corn would have anything to do with the size of the shovels to be used. In their reasoning, the children should be expected to apply their knowledge of the spreading, fibrous root system of the corn plant to the end that their conclusion will be against the use of large shovels after the spreading root systems have taken possession of the ground. This reasoning is sound; and it should lead to the decision that while large shovels may be used at the first cultivation, smaller ones should be used as the corn becomes larger.

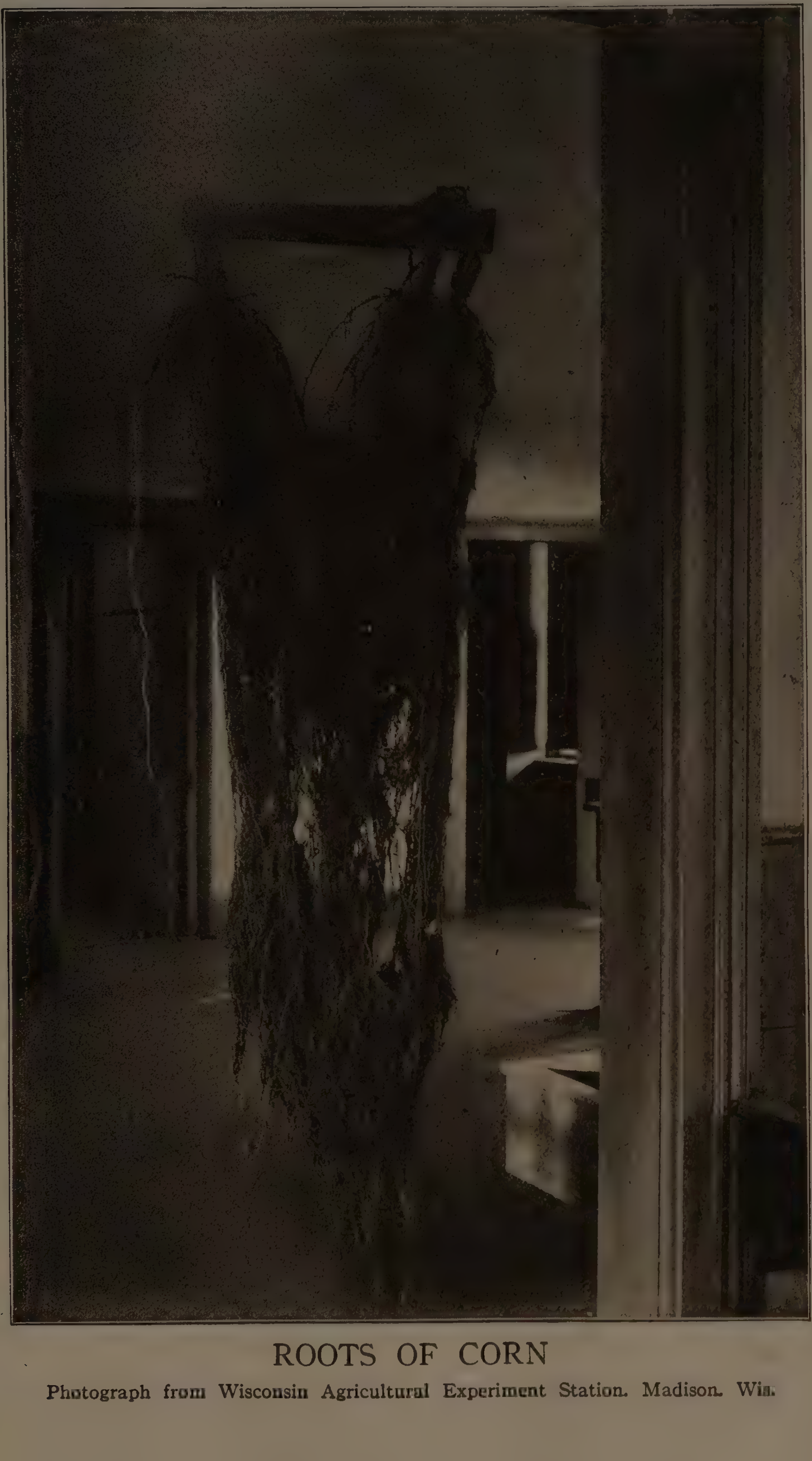
It is not advisable to fix upon any definite number of times for the cultivation of corn since good practice varies widely according to climatic and soil conditions. However, the fact should be emphasized that during dry seasons, and also in those sections which normally have scant rainfall, cultivation with very small shovels merely to maintain a dust mulch and thus to conserve moisture, may be profitably continued long after the corn has become so large that it would ordinarily be "laid by."

(e) THE SELECTION AND STORAGE OF SEED. In those parts of the corn belt where the season is barely long enough to permit the crop to ripen, it is necessary, as we have already seen, to select the seed from those ears which mature earliest. This work should be done in the field before the first hard frost, which may be expected to injure or destroy the vitality of the seed unless the latter is thoroughly dry.

Ask the class to make a list of all the characteristics of the corn *plants*, which they would consider if they were sent into a field at the time designated to select ears for seed; and also ask that they state the reasons why they think that these characteristics should be considered. Allow them some time to think it over, since it is a question that is not easily answered offhand. The list which they make should correspond more or less closely with the following:

(1) The plant should be early in maturing as shown by a well ripened ear; this in order that the corn which grows from it the succeeding season may be expected to mature early.

(2) The stalk should be strong and sturdy, as seed of strong vitality cannot be expected from plants that are weak and spindling.



ROOTS OF CORN

Photograph from Wisconsin Agricultural Experiment Station. Madison. Wis.

(3) The ear should be borne at a medium height since others are difficult to husk.

(4) The ear should hang with tip downward. If the tip points upward instead, rain may enter; and when it gathers about the base of the ear, molds or decay will result.

(5) The husks should not be heavy and closely wrapped about the ear, nor should they be so loose as to expose the tip. In the first case, the ear will be very difficult to husk; in the second, the kernels about the tip will be injured by the elements or by insects.

(6) If a barren stalk is near, the ear should be rejected for the reason stated in our study of flowers.

(f) JUDGING THE SEED EARS. After the consideration of the parent plants, the ears, themselves, should be judged carefully as to their desirability for seed. Since the children cannot work out for themselves the standards of excellence that have been established by corn growers, they are stated briefly below essentially as they usually appear on the score card:

(1) The ear must be thoroughly *mature* and show no signs of weak vitality, such as mold at the tips of the kernels, chaffiness, blistered or discolored germs, etc.

(2) The *size* of the ear desired is governed by the latitude for reasons previously stated in this chapter. In Iowa and Illinois, it is held that the ear should be from eight to ten inches in length; north of these States, it should be somewhat smaller, while in the southern States it should be larger.

(3) In *shape*, the ear should taper very gradually from butt to tip.

(4) The *tip* should be well covered with kernels that are dented rather than round and shot-shaped.

(5) The kernels at the *butt* should be uniform in shape, rather than irregular and blocky; and they should fit closely about the depression at the end of the cob.

(6) The *rows* should be straight and as free as possible from depressions.

(7) The *kernels* should be keystone-shaped and of medium depth, except in the southern States where deeper kernels are desired. This matter requires careful attention, as sharply pointed, round, square or rectangular kernels are highly objectionable.

(8) The *germs* should be large, by which we refer to the depth, or thickness, as well as to the length and width.

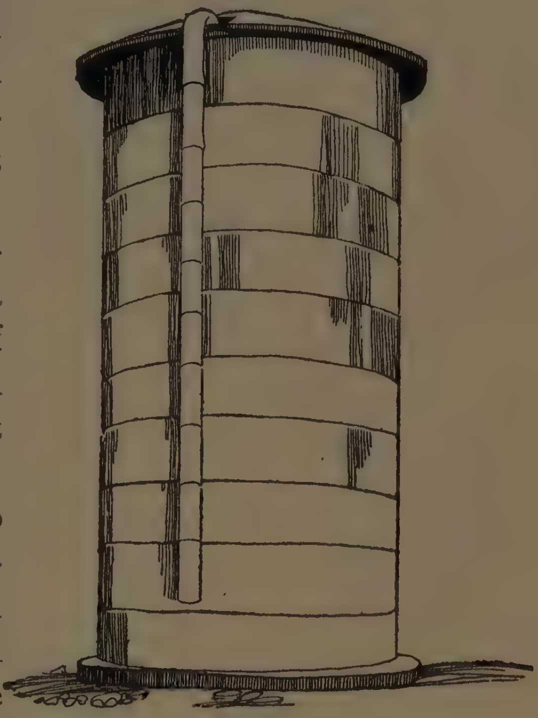
One of the most valuable exercises for the class is the judging of seed ears according to the standards given above. After they have become perfectly familiar with these standards, place ears before them to be ranked according to their various degrees of excellence. At first the children will find it exceedingly difficult to judge and rank the ears according to the standards which they have in mind; but with practice will come real skill as well as ability to give sound reasons for their conclusions.

(g) THE HARVESTING OF THE CROP. A peculiarity of all of those plants whose seeds are eaten by animals is that, as food is stored in the seed, other parts of the plant — as the leaves and stems — which were before digestible become gradually indigestible. Corn belongs to this class of plants. Up to the time that the process of seed formation gets under way, nearly the entire plant is digestible and greatly relished by animals; but after the seeds become filled out and hard, the stems and leaves gradually lose their green color and become woody and indigestible. It is true that the total food value of the plant is about a third greater just at the time that the kernels become hard than when the crop has ripened.

Ask the class to name as many ways of harvesting the corn crop as they can. The three plans of cutting and curing for fodder, cutting and storing in the silo, and husking the ears only and storing them in the crib should be given. Discuss then the relative advantages, or merits, of these three methods. For the first two, which are performed just at the time when the kernels have become hard and glazed, it may be justly claimed that they yield a considerably higher food value than can be secured by waiting until the plant is ripe and using only the ears. However, if the latter plan is followed, and the dead stalks are worked back into the ground, the supply of humus in the soil may be better kept up; and this, as the class will remember, is a matter of very great importance.

6. How Corn Is Used. Require the class to make a list, showing all the uses of the corn plant that are known to them. When complete, it should be about as follows:

(1) The *ears* are fed to animals. Most of the domestic animals that furnish our meat supply are fattened upon it. This is by far the most important use of the crop.


SILO

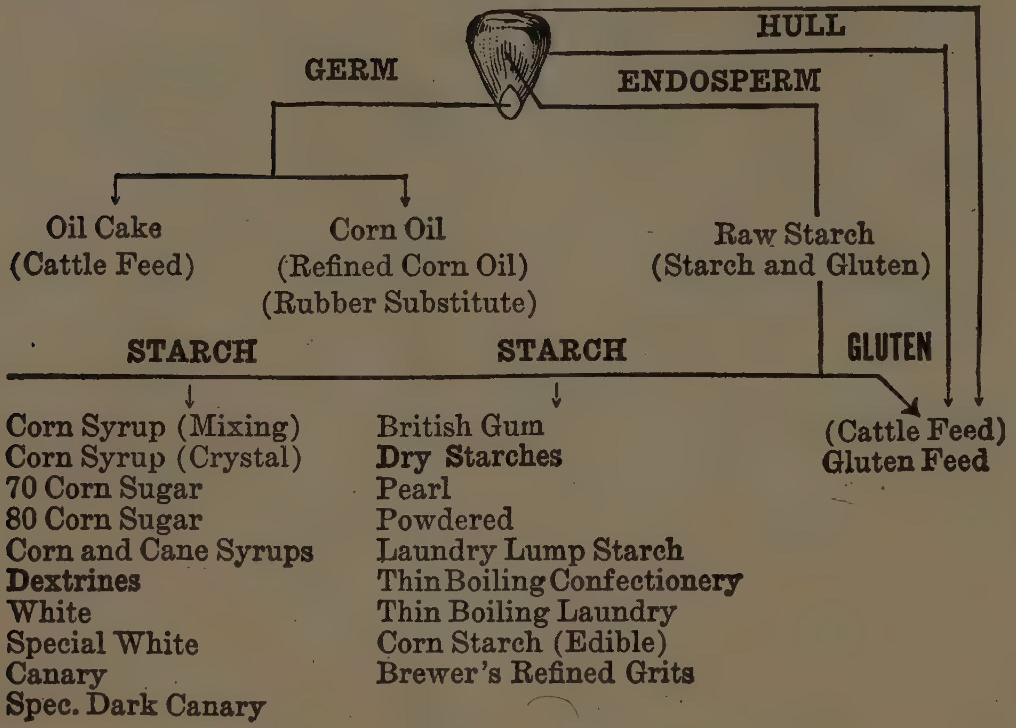
(2) The *leaves* and *stems* are fed to animals, especially in the form of silage or fodder.

(3) Corn in various forms is used as food by human beings. Among these forms are corn meal, hominy, canned corn, roasting ears, corn starch, corn sirup, etc.

(4) Certain manufactured products are prepared from corn. Among these are corn oil, also a substance used as a substitute for rubber which it very much resembles, alcoholic products, and many others.

7. Crops Used as Substitutes for Corn. In the western parts of the corn belt where the rainfall is sometimes scant during the hot months of summer, other crops which resemble corn in certain respects, but which are far better able to endure dry weather, are grown instead. Among these are Kafir corn, millo maize, feterita, durra, and others.

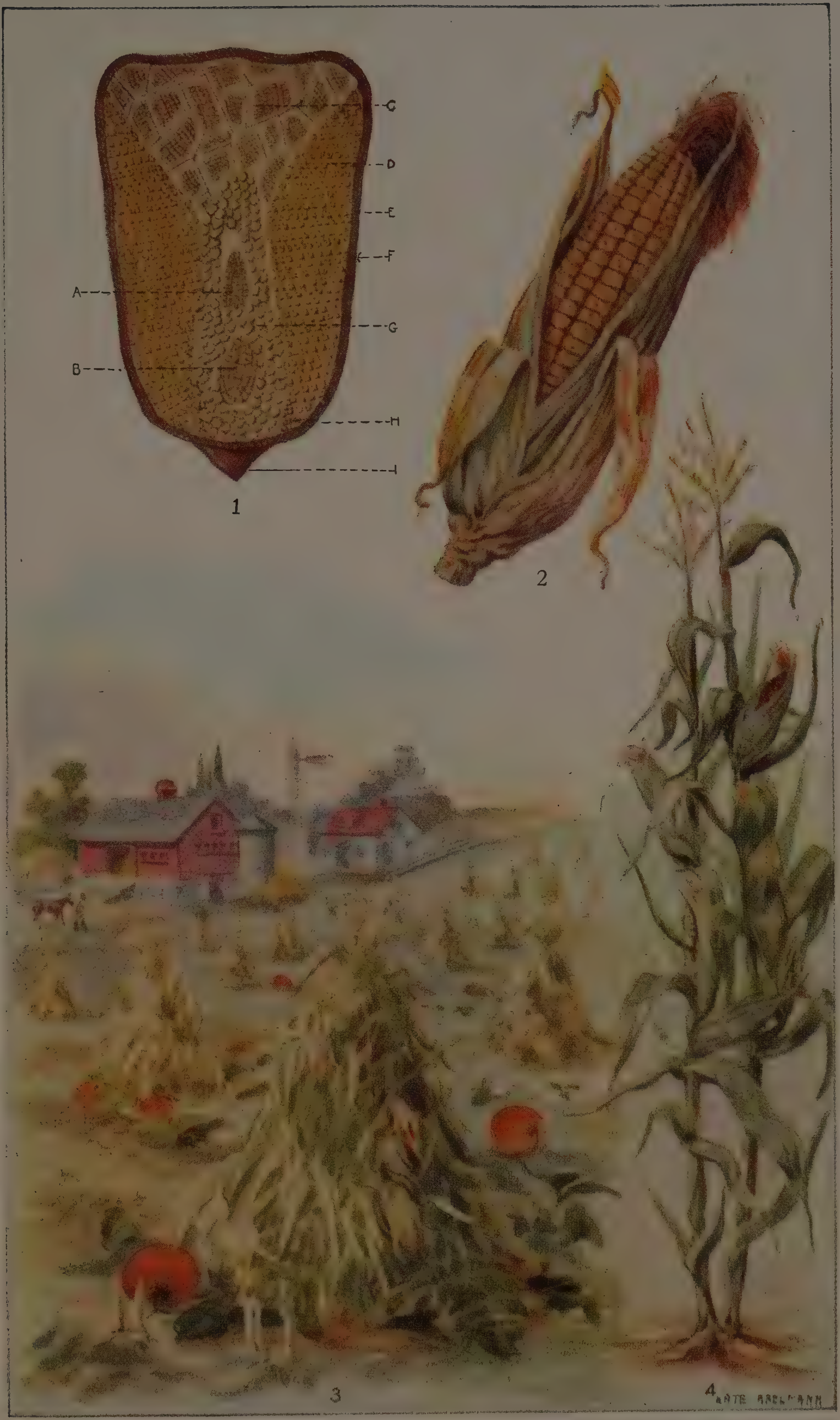
Like corn, they are giant grasses; but the resemblance practically ends here. They bear no ears. Instead their seeds are borne in great spikes, or heads, at the top of the plant as in the case of ordinary sorghum cane, to which they are closely related.



PRODUCTS MADE FROM THE CORN KERNEL
Courtesy of the American Manufacturers Association of Products from Corn.

In food value, the seed does not differ greatly from corn, though the yield is usually somewhat less. These plants are even more tropical in their character than is corn, their native home being in Africa. As a result, they are planted later in the spring; and since the seeds are much smaller, they must be planted at less depth.

The effect of introducing these African plants into the United States will prove an interesting topic for discussion. They have made agriculture profitable in many parts of the West and Southwest where otherwise it could never have been successfully carried on; and as a result, there are many well-settled and important farming sections which would



Painted for Public School Methods by the Art Institute, Chicago

CORN

1—Cross-section of kernel: (a) Embryo stem; (b) Embryo root; (c) crown starch; (d) horny starch; (e) horny gluten; (f) hull; (g) germ; (h) tip starch; (i) tip cap. 2—Ripened ear. 3—Harvest of the corn. 4—Growing corn.

hardly have been settled at all but for these strange plants brought to our western plains from far distant lands.

WHEAT

8. Importance. Introduce the study of wheat with a question as to what is really the most important of all the crops cultivated by man. This will open the way for an interesting debate, particularly if champions of both wheat and corn are found in the class. It is immaterial how it may terminate; but the essential fact should be brought out clearly that just as Indian corn is preëminent as a feed for animals, so wheat is preëminent as a food for man. This may seem to leave the advantage with wheat until we remember that the majority of the animals to which corn is fed eventually become human food also.

Discuss, then, the different forms in which wheat is used as food and the manner in which they are prepared. Thus in the manufacture of flour, both the embryos and the seed coats of the wheat grains are removed, so that the white, starchy part, which Nature meant as the food supply for the germinating plant, becomes our own food instead. In making graham flour, nothing is removed, while in whole wheat flour, only the coarsest part of the bran is taken out.

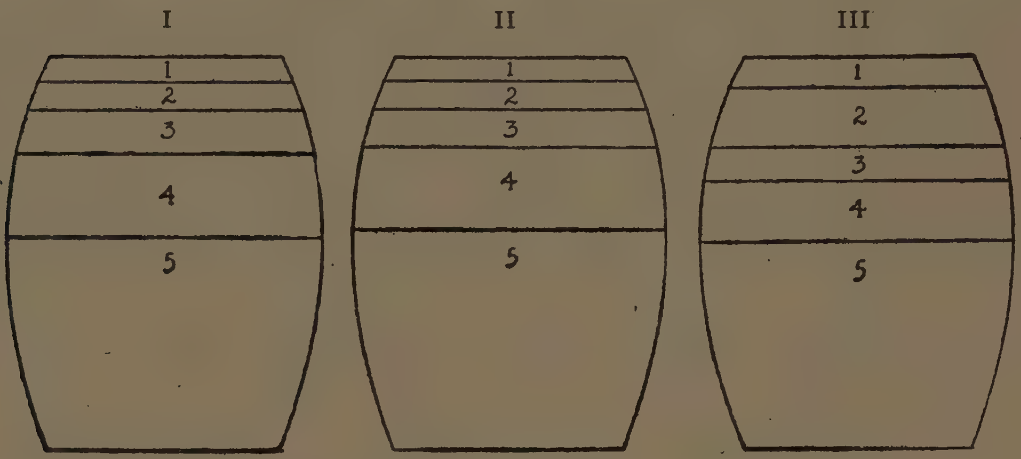
9. How the Wheat Plant Differs from Corn. Since both wheat and corn belong to the grass family, they resemble each other in many ways. Both, for example, have fibrous root systems, jointed stems, and long, parallel-veined leaves; and these facts should be brought out as showing the relationship that exists between them. Ask, then, that the class name as many ways as possible in which the two plants differ. The great difference in size, the fact that the stem of the corn plant is filled with pith while that of wheat is hollow, and several others of similar character will come up for consideration; but the essential point upon which the discussion should be made to hinge is the great difference in the inherent natures of the two plants as to the climatic conditions which they demand, since this furnishes the clue as to the proper methods of culture. We have learned that corn is a tropical plant, for which reason its growing season extends only from the last frost of spring to the first one of autumn. This is not true of wheat at all.

Allow the class to think over the question of when the growing season of the wheat plant really begins and ends. They should decide that the growing season of wheat is the *cool weather* of spring rather than the hot weather of summer since it ripens and is harvested at about the beginning of the hottest part of the summer season. The truth is that wheat is by nature and origin a plant of the temperate zone and makes its most rapid growth in cool weather, just as corn grows fastest in hot weather. Inquire, then, where the best wheat would probably be grown — in warm states like Texas or Florida, or in those farther north like Minnesota and the Dakotas. The general rule is that the best wheat grows in northern latitudes though there is an important exception as we shall see in the next section.

10. Two Great Classes of Wheat. What is the effect if corn, a tropical plant, is taken so far northward that its growing season is cut shorter than the plant requires? The answer of the class will be that, since the growing season is brought to an end by cold weather, the crop will be destroyed by freezing before it has matured.

Inquire now what would be the effect if wheat, a temperate zone plant, were taken so far southward that its growing season would be shorter than the plant requires. This question will not prove so easy, since the growing season is brought to an end not by cold but by hot weather. The growth, however, in this case is cut short, the grain becoming ripe before the kernels have become large and plump; and so the yield is greatly reduced. It follows that a growing season of proper length is nearly as important for wheat as for corn.

Men have found a way to increase the growing season for wheat in some southern sections. What is it? Let the class think over the problem carefully if it proves difficult. The solution is that the cool weather of the autumn is made a *part of the growing season* by originating and raising varieties of wheat that are able to live through the winter. Such wheat is sown in the fall, makes part of its growth before cold weather, rests during the winter and completes its growth in the spring before the hot weather comes. It is known as *fall* or *winter* wheat, while that grown farther north, which is sown in the spring, is called *spring* wheat. Winter wheat, like corn, is being grown farther north each year.



COMPOSITION OF WHEAT FLOUR

I. Bakers' or Family Flour.
  1. Ash.
  2. Fat.
  3. Water.
  4. Tissue-building material.
  5. Energy-giving material and fiber.
II. Graham or Whole Wheat Flour.
  1. Ash.
  2. Fat.
  3. Water.
  4. Tissue-building material.
  5. Energy-giving material and fiber.
III. Different Products Derived from Milling Wheat.
  1. Shorts, screenings, waste.
  2. Bran.
  3. Low grade flour.
  4. Bakers' flour.
  5. Patent flour.

In the United States, Minnesota and North Dakota are the leading States in the production of spring wheat. Dakota, Minnesota, South Dakota, Kansas, Nebraska, Missouri and Illinois lead in the production of winter wheat. The provinces of the Canadian northwest — Montana, Alberta and Saskatchewan — are great wheat-producing regions. Here spring wheat is the leading crop, but winter wheat is grown successfully in many localities. Russia, including Siberia, Roumania, France and Argentina are the foreign countries important in the production of wheat.

11. Preparing the Seed Bed for Wheat. How should the seed bed for wheat differ from that for corn? It is to be remembered that the plant does not make so rapid growth as does corn. Hence it is not necessary that the ground be so loose and mellow since the roots do not have to penetrate it so quickly.

While it is generally held that the upper two or three inches should be loose and well pulverized, below this depth, the seed bed should be firm and compact.

Usually the ground is not plowed in making it ready for wheat, but the disc and harrow are freely used. If the plow is used, time is allowed for the soil to settle and become firm before sowing the seed.

12. How the Crop Is Cared for. From this point, the class will probably be able to describe the successive steps in producing a crop of wheat without help. They should be given about as follows:

(a) THE SOWING OF THE SEED. There are two methods of doing this. It may be scattered broadcast with an ordinary seeder, or it may be planted with a drill, in rows which are only a few inches apart. In the former case, it is covered with a harrow or disc, while in the latter case, the drill covers it at a uniform depth.

(b) THE HARVESTING OF THE CROP. The wheat is usually cut with a self-binder though in some sections a header — so called because it removes only the heads — is used instead. If the self-binder is used, the grain should be cut before it is fully ripe or it will shatter while being handled and much wheat will be lost; but if the header is used, the grain must be well ripened or it will mold in the stack.

(c) SHOCKING OR STACKING. After the crop is cut, it is usually either shocked or stacked to await the arrival of the threshing machine.

OATS

13. Character of the Plant. In the study of wheat it was made clear that plants may differ in their natural climatic requirements just as do animals and that a knowledge of their character in this respect is necessary if we are to cultivate them successfully.

Inquire what kind of a climate is required by oats as compared with those demanded by corn and wheat. This discussion may give to oats a character which is new to some of the pupils. For their best growth, they require a *cooler* climate even than does wheat; and they are injured more than wheat by the arrival of hot weather near the end of their growing season. With the foregoing fact in mind, ask which should be sown first in the spring—oats or wheat. Since oats thrive in cooler weather, they are sown earlier as a rule. Inquire then why it is that oats and corn rarely do well in the same locality in the same season. The decision should be that if the season is cool enough for oats it is too cool for corn, or that if the weather is suitable for corn, it is too hot for oats. Put the question now as to what parts of the world produce the best oats. Canada and northern Europe easily lead other countries not only in the average yield per acre in bushels but in the weight per bushel. A bushel of oats by measure averages about thirty-two pounds in weight in the United States; but in Canada, it usually weighs from forty to fifty pounds.

OATS

14. Two Classes of Oats. We learned in the preceding section about winter and spring wheat. Inquire whether, in view of what has been said as to the character of the oat plant, there exists the same necessity in southern regions of a winter variety of oats as of a winter variety of wheat. The decision should be that since oats are more injured than wheat by the arrival of hot weather before they are mature, there is even greater reason why they should make a part of their growth in the fall. Are winter oats known? The class may be surprised to learn that practically the only oats grown in the southern and the Pacific States are winter oats, and that like corn and winter wheat, they seem to be gradually working their way northward.

In the north central and northern States, as well as in Canada, however, only spring oats are raised. An interesting and instructive discussion will follow the question as to where *early* varieties of spring oats ought to be sown — that is, in the northern part of the spring oat belt, as in Canada, or in the southern part, as in Missouri or Kansas. Give the children a little time to think it over. Then they should answer that early varieties should be sown not in the northern but in the southern part of the spring oat belt, because the growing season of oats is brought to an end by hot weather; and so the earliest varieties, which are those that mature most quickly, should be grown where hot weather comes earliest. Ask, then, if the same rule holds in the case of corn; *i.e.*, that early varieties should be grown in the South and later varieties farther north. By the same reasoning, they will find that the rule for corn is the reverse of that for oats since the growing season of corn is brought to an end by cold weather and the earliest, or quickest maturing varieties should be grown where the cold weather comes earliest.

15. Preparation of the Seed Bed. The oat plant is similar to wheat in that it requires a seed bed that is loose and mellow only near the surface, but firm and compact below.

The seed bed for oats may be pulverized and stirred to even less depth than that for wheat. This accounts for the fact that many farmers sow oats in cornstalks or in stubble ground, discing and harrowing it afterwards. Thus they cover the seed at the same time that they are putting the seed bed in proper condition for the growth of the young plants.

16. The Care of the Crop. The oat crop is cared for in very much the same way as wheat. The seed may be sown broadcast or with a drill. The crop is not cultivated, except that it is sometimes harrowed while the plants are small, especially if the field is weedy, the object being to kill as many weeds in the white stage as possible. The crop is usually cut with a self-binder, and shocked or stacked to await threshing.

By many people, oats are highly prized as a hay crop. Indeed their value when used in this way is beyond question. Inquire as to when they should be cut if they are to be used for this purpose. The class will remember from the study of corn that the total food value of any plant is greatest at about the time that the seeds are becoming hard. This applies to the case of oats to be used as hay. They should be cut when the kernels are in the "dough stage."

BARLEY

17. Character of the Crop. Among the small grains, the barley plant is to be regarded as one of many peculiarities. It is supposed to have originated in north central Asia and hence we should expect it to be adapted naturally to the cooler parts of the temperate zone. We are not surprised, then, to learn that it thrives in northern lands such as Norway, Sweden, Alaska and Siberia. Indeed it will even grow and mature in some localities where the soil thaws to a depth of only a few inches during the entire summer.

Like corn, however, barley has spread into other parts of the world having climates far different from that to which it is adapted by nature. Inquire as to whether the barley and the corn plants have moved in the same or in different directions in their migrations. While corn has moved northward, barley has of course moved southward. Ask then as to what the effect of the migration has been upon each plant. Corn has become gradually smaller and somewhat more difficult to grow as it has reached cooler and cooler climates and we should expect to find barley becoming less productive as it got farther south. This has not proved to be the case, for the new homes in warmer climates have seemed to suit it even better than did the old one. It is really true that barley is now regarded as naturally a warm climate plant, owing to the fact that it seems to thrive best in southern lands.

It follows that it has a wider range than any other cultivated grain since it does well in nearly any climate.

18. Importance of Barley. It may seem to the class that in view of what has been said, barley should be the most generally cultivated of all the grains. Inquire if this appears to be true. They will promptly decide that it does not since there are few localities in which barley seems to be the principal crop. Why is this? If the class is at all familiar with the crop, they should decide that while wheat provides a better food for human beings than does barley, corn and oats provide a more satisfactory food for animals; and so barley is a sort of second choice crop.

Aside from this, many farmers dislike to handle barley because of the long beards, which work through the clothing and scratch the skin, making the work of threshing it very unpleasant.

19. Methods of Cultivation. In general, barley is taken care of about as are the other small grains already studied. The seed bed is prepared similarly to that for oats. Like oats, barley is often used for hay, the plants being cut while the seeds are in the milk or in the soft dough stage.

As in the case of wheat and oats, there are two general classes of barley, winter and spring.

RYE

20. Character of the Plant. The more we study plants, the more clearly we discern the fact that they, like people, have their individual peculiarities. The rye plant is distinguished by its hardihood. It can withstand unfavorable climates and soils and still thrive as can no other grain crop under like circumstances.

Both winter and spring rye are grown. A striking fact is that winter rye can be grown as far north as Alaska. This means that the young plants which grow from fall-sown seeds are actually able to live through the long and intensely cold Alaskan winter and begin growing again when spring comes.

21. Where and How Rye Is Raised. As a rule, rye does not yield so well as other small grains; neither is it so valuable as others either as a food for human beings or for live stock. With these facts in mind, ask the class to state, in a general way, where rye would probably be an important crop. The question may require some thought though the answer is obvious. In those regions where, owing to poor soil or unfavorable climate, other crops *are not certain*, rye is extensively grown.

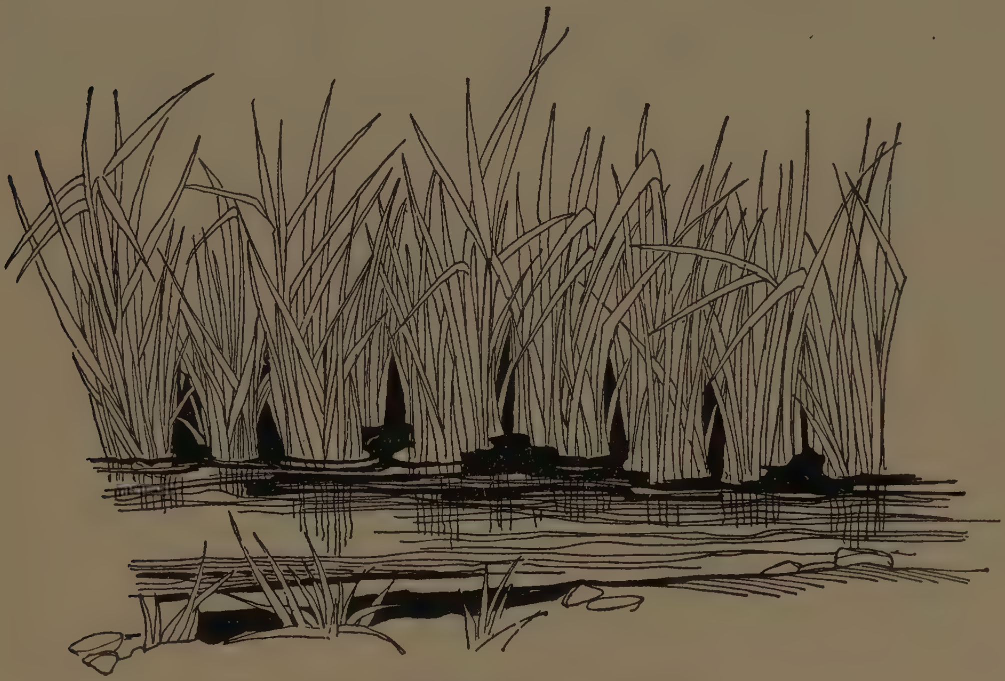
In the United States, little spring rye is raised. Instead, the seed is sown in the fall; and when the growth becomes sufficiently heavy in the spring, it is used as pasture for live stock. If it is not pastured too heavily and if the animals are not kept in it too long, it often matures a crop of grain — another fact which illustrates the ability of this remarkable plant to succeed under adverse conditions.

RICE

22. The Character of the Plant. If the class is entirely unfamiliar with rice and the methods used in growing it, they should be asked to read something about it; or this duty may be assigned to one or more members with the request that they make their report as a part of the following recitation.

In the discussion of the crop, the question should be put as to what constitutes the greatest difference between rice and the other crops which we have studied. The answer will probably be that the most striking difference lies in the great amount of water which the rice plant requires.

Inquire then if it is really necessary that rice have so much more water than other plants. The truth is that considerable rice is grown with no other water supply than that received from rains, such as other crops receive. This is known as upland rice; but it is not quite so good, as a rule, as that which is flooded at times. It follows then that while rice can grow under the same conditions as other crops, it seems to grow better if it can stand in water at least a part of the time. The class will remember that in the study of soils, it was stated that the roots of plants must have air but that water excludes the air from the soil, which makes drainage absolutely necessary for ordinary crops. Are we to understand, then, that in rice we have a



RICE GROWING IN WATER

plant whose roots require no air and that this is the reason why the roots may be submerged? Allow some discussion of this point since it is quite important. The class should remember that fish and other aquatic animals live in water; yet they require oxygen just as other animals do. Where do they get it? They are supplied from that which the water dissolves from the air, for water dissolves oxygen just as it dissolves sugar. The difference between rice and other grains is that it roots are able to take their oxygen supply from that which is dissolved in water, while other farm crops cannot do so.

23. How the Crop Is Cared for. The class will have noted that most rice is grown where it is possible to flood the land at will. It simply becomes a question then as to when the water should be turned on and when it should be withdrawn. The planting is usually done while the land is dry or nearly so. Then the field is flooded for a few days while the seed germinates, after which the water is withdrawn until the plants are from six to eight inches high. Then the water is turned on the crop a second time; and it is kept there, though it must be constantly renewed, until the seeds are in the milk stage. At this time, the water is again withdrawn and the grain allowed to ripen. It is cut and threshed as are other grains. As it comes from the machine, each kernel has a close-fitting hull not unlike that of barley; and it is necessary to send the threshed grain to a mill where these hulls are removed before it can be used as food.

THE GRASSES

24. Two Uses of the Grass Crops. We have found that practically all of the important grain-producing plants are really grasses. However, there are some grasses whose seeds are of little or no value as food, but which are regarded as valuable for other reasons. Inquire what are the two chief purposes for which these grasses are grown. After the class has decided that they are usually used either as pasture or for hay, ask what is the distinction between a pasture and a meadow, and whether the same kind of grass is commonly used for both purposes. This will lead of course to a discussion of the characteristics of good pasture and meadow grasses.

A pasture grass should be capable of making continuous growth throughout the season in spite of the fact that its leaves are being constantly eaten off by livestock. Ask if there are many plants among those which we have studied, that can withstand such treatment. The truth is that none of the grain crops could live long if their leaves were eaten away as fast as they are formed. Rye, which is hardiest of all, is most nearly able to endure such abuse; and, as we have seen, it is used to some extent for pasture. It is obvious then that a good pasture grass must be far hardier than most other cultivated plants. However, it should differ from them in still another way, for while they are mostly annuals, it should be a perennial, since otherwise it would be necessary to sow the seed for a new pasture every year.

A good meadow grass does not need to be capable of growing continuously while its foliage is being removed, since it is not cut often. But while it may be much less hardy in this respect, it should be capable of making a heavier, denser growth of foliage in order that the yield of hay may be large. Moreover, since farmers do not wish to sow the seed each year, the meadow grasses, like the pasture grasses, should be perennials.

25. The Standard Pasture Grass. If the class is asked to name a typical pasture grass, their answer will probably be blue grass, or otherwise, Kentucky blue grass; but if they are asked just how a pasture of Kentucky blue grass is established, they will be uncertain. The truth is that the great majority of blue grass pastures have never been sown. When white men made their first clearings in the forests of the New World, blue grass was found waiting to overrun them. When the open prairies were broken later and put into grain crops, the blue grass was nowhere to be seen. Yet if after this time any field was allowed to remain for two or three years uncultivated, the blue grass quietly took possession. It has been so ever since. Most of the blue grass pastures that we see were originally put into some other perennial grasses and after two or three seasons, the blue grass has crowded them out. There are many farmers who sow a little blue grass seed with timothy or clover; but by many others, this is not regarded as at all necessary.

In the limestone soils of Kentucky, blue grass grows most luxuriantly; but southward from Kentucky, it does not do so well as it does somewhat farther north. Ask the class to account for this — from their own observations if possible. They should have noticed that the heat of midsummer checks almost completely the growth on this grass and that pastures of it become dry and short. In the South, where the hot season is longer, this objection to it becomes much more serious.

26. The Standard Meadow Grass. Just as Kentucky blue grass is the standard pasture grass, so timothy is the standard meadow grass in the United States. Unlike blue grass, it must be seeded. Ask the class to find out how this is usually done. The seed is ordinarily mixed with that of small grain, such as oats or wheat, and the two sown together, clover being frequently sown at the same time. The small grain, which matures in three or four months, is harvested and removed from the land by the time that the young timothy plants have become well established; and after this, the timothy has possession of the ground.

An interesting characteristic of the timothy plant is its habit of storing food in an enlargement in the stem just above the surface of the ground. Ask the children to find and bring to school if possible some mature plants showing these enlargements. Inquire, then, as to when the plant should be cut for hay. The answer is that it should not be cut until these enlargements have appeared at the base of the stems, since the food stored in them is necessary for the further growth of the plant. Very often timothy dies or is greatly weakened by being cut too soon.

If time permits, the class should be required to make a study of Bermuda grass and brome grass, which are extensively grown in certain parts of the country, and also of redtop, which is adapted to low, poorly drained ground where other pasture and meadow grasses do not thrive.

THE LEGUMES

27. Characteristics of the Legumes. The study of this large and extremely useful family of plants should be introduced by a comparison of the blossoms of various familiar plants. The garden pea or the sweet pea may be taken as a type of the flower of the legumes and the question should be asked as to how this flower differs from certain others, as the wild rose or the buttercup. This will lead to a discussion of the irregular shapes and sizes of the petals of the sweet pea blossom; and in case the class has had work in botany, the parts of the corolla; *i.e.*, the standard, wings and keel, should be called up again in review.

Inquire now if there are any other familiar plants having blossoms similar to those of the sweet pea.. The bean will probably be named since its flowers are of the same pattern. Ask finally for a comparison of the blossoms of the sweet pea and the red clover. At first, the class will see no points of resemblance between these flowers; but if they are given a chance to examine them, they will discover that the head which we call the blossom of clover is really a mass of tiny flowers, each of which is similar to that of the sweet pea; and if the blossoms of other clovers or of alfalfa can be examined,

SWEET PEA BLOSSOMS

it will be found that the individual flowers are similar to that of the pea in every case. From this and other like evidence, we know that all of these plants belong to the same family; and those members of the family which are cultivated by farmers are called *legumes*.

28. Why Legumes Are Grown. Nearly every farmer is a staunch friend of the legumes. There is a reason for this.

One of the remarkable facts about these plants is that they almost always leave the soil in a more fertile state than they found it. As we have seen, this is not true at all of other crops. It is their well-merited reputation as restorers of fertility that has made the legumes so greatly desired by farmers generally. There are three distinct ways in which they increase the fertility of the soil. The class should reason these out for themselves since they are already in possession of the necessary information.

(1) The bacteria which live in the nodules on the roots of the legumes take nitrogen from the air and convert it into a form which plants can use as food. In this way the store of nitrogen in the soil is increased. This was explained at some length in the section relating to soils and tillage.

(2) These crops are quite commonly plowed under, thus greatly increasing the amount of humus in the soil; and as we have seen, the maintenance of a supply of humus is a matter of extreme importance if we wish to conserve the fertility of the land.

(3) Since the legumes do not belong to the grass family but are broad-leaf plants instead, their root systems are not fibrous but extend deep into the soil. It follows that they bring plant food from great depths leaving it, when they decay, near the surface where the shallow, spreading roots of the grain crops can get it.

There is still another reason why the legumes are so favorably regarded by farmers. It is that without the pasture and hay which these plants produce, live stock can not be made to do well save by the purchase of expensive feeds.

29. The Most Important Legumes and Where They Grow. The members of the class should be able to name several at least of the common legumes. However, they should be asked to make up a list of not less than ten, stating in what part of the country each one is chiefly raised. The list should contain when completed most or all of the following plants:

(a) Red Clover, which grows from central Missouri and the Ohio River northward to Canada and eastward to the Atlantic Ocean.

(b) Crimson Clover, which thrives in the Southern states, particularly those of the Atlantic seaboard from New Jersey southward.

(c) Alfalfa, which is grown chiefly west and southward of the Missouri River. It thrives in the irrigated valleys of the mountain states and in the agricultural lands of the Pacific states. From the Missouri it is slowly but steadily spreading to the eastward so that it is now grown in practically all of the Eastern states, as well as those of the central part of the country.

(d) Japan Clover is grown from Kentucky and southern Missouri southward to the Gulf.

(e) Sweet Clover, which grows as a weed along the roadsides and elsewhere in nearly every part of the United States. In recent years farmers have taken to cultivating it and there are many who prize it highly, particularly because of its exceptional merits as a restorer of worn-out soils.

(f) White Clover, a small, creeping plant, which appears in our pastures and disappears from them, often in rather a mysterious way since we are not always able to account for its coming and going. It is best known in the region where red clover is most extensively grown.

(g) Peas, such as are grown in our vegetable gardens.

(h) Canadian Peas, which are grown for pasture and hay from the Canadian line southward as far as the latitude of central Iowa and Illinois.

(i) COWPEAS, a crop similar to the Canadian field peas, but adapted to the climate of the warmer states farther south.

(j) BEANS of all kinds.

(k) SOY BEANS, which really resemble cowpeas more closely than they do beans, and which are grown from the Southern states northward as far as Wisconsin.

(l) PEANUTS, which are an important crop in Virginia, North Carolina and Tennessee.

30. Difficulties in Raising Legumes. While all farmers recognize the wonderful character of the legumes as soil builders, it is still true that they look upon most of these crops as very difficult to grow. This is particularly true of those which are raised as general field crops, such as the clovers and alfalfa.

There is no more important or interesting question to be considered in the study of agriculture than that relating to the causes of the failures with clovers and alfalfa, which are becoming much more numerous in recent years throughout the leading agricultural states. The causes of a part of these failures are easily understood and the class should be able to reason them out; but others will probably require careful explanation on the part of the teacher. The six here mentioned account for a very large majority of clover and alfalfa failures. They are:

(1) The soil is lacking in *humus*.

(2) The *bacteria* which the plants require in order to make healthy growth are not present.

(3) The *nurse crop*, which is sown with the clover, and among which the little clover plants are expected to make their start, cuts off their sunshine and robs them of the moisture and plant food which they should receive from the soil.

(4) The soil is lacking in *lime*, of which all legumes require large amounts.

(5) The soil is deficient in *phosphorus*.

(6) The young plants are killed by the droughts of midsummer or other unfavorable *weather conditions*.

31. How to Succeed with Clovers and Alfalfa. Taking up one by one the causes of the clover and alfalfa failures named above, the class should be asked to think out definite plans by which they might be avoided and by which success with these useful crops would be made more certain. For the most part they should be able to do this without help though some details as regards the methods used may require explanation.

(a) HUMUS. How may the amount of *humus* in the soil be increased? In our study of soils, we found four methods by which this might be accomplished. However, one of them — that of plowing under green manure crops — is not usually practicable since the green manures commonly used are the legumes, themselves. Instead, the humus supply for the clovers is usually provided by scattering barnyard manure over the land.

(b) BACTERIA. Regarding the need of proper bacteria, it may be stated as a rule that each kind of legume *must* have the particular kind of bacteria that is suited to it if it is to succeed. The soil may or may not contain these bacteria; but if not, they must be introduced. How can this be done? Allow the class to think this over carefully since they should be able to work out the method generally used. Soil is brought from another field, in which the crop that we wish to raise is growing or has grown successfully, and scattered over the ground where the seed is to be sown, usually at the rate of only two or three hundred pounds per acre. This is known as *inoculation*. It should be performed on cloudy days or in the evening; and the newly-scattered soil should be harrowed or disced in at once, owing to the fact that the bacteria are quickly killed by direct sunlight.

(c) NURSE CROP. In the leading agricultural states of the central part of the country, the clovers are usually sown with the seed of some small grain. This small grain, which is known as the *nurse crop*, ripens and is harvested within three or four months; and after this the little clover plants are supposed to take and keep possession of the land for one or more years. The nurse crop in this case is poorly named since it does not help the young clover plants at all, but hinders them very seriously, instead, as already explained. Of all the small grains, oats are the most harmful when used in this way, as they shade the ground more completely and use larger amounts of moisture and plant food than do the others. It is better to use a crop which produces less shade, as wheat, barley, or rye; and it is still better to use a winter variety of these crops as they ripen early and so do not shade the ground for so long a time.

(d) LIME. To determine whether any given field should have *lime* before clover or alfalfa is sown in it, a very simple test may be used. If some of the soil from the field is moistened with rain water in a clean dish until it forms a very stiff mud and a slip of blue litmus paper is then inserted in it, the paper will change to pink or red in color within an hour in case the soil is deficient in lime. This paper may be bought at small cost at most drug stores. It is peculiar in that it will change from blue to pink in any acid. To show this, the children should be asked to try it in water to which a few drops of vinegar or lemon juice have been added, as both of these contain acids. They will then understand clearly that when the same change in color occurs in a slip that has been inserted in the soil, it, too, must be *acid*; and lime, or better yet, ordinary limestone, will neutralize or correct this acidity. It should be quite finely ground and spread at the rate of from one to three or four tons per acre. It should be harrowed or disced in, but not plowed under. Bulletins may be secured without charge from the experiment stations of most of the states, explaining the details of this important work.

(e) PHOSPHORUS. In many of the eastern and southern states, as well as in some of those of the central part of the country, *phosphorus* is lacking and must be applied before the legumes will succeed. The use of barnyard manure or of commercial fertilizers containing phosphorus is necessary to correct this condition.

(f) Moisture. How to prevent the death of the young clover or alfalfa plants as the result of dry weather or other unfavorable weather conditions is a problem that the class will be unable to solve. The only solution so far found lies in the correction of all other causes of failure already discussed. It is known that if other conditions are all made favorable, the little clover plants do not succumb nearly so easily to unfavorable weather conditions. Indeed there are many good farmers who believe that young clover and alfalfa plants are able to withstand unfavorable weather conditions provided all other conditions are favorable to their growth.

32. How Some Common Legumes Are Grown. At the discretion of the teacher, the methods of culture of a few of the more common legumes should be made a matter of special study. To this end, given crops may be assigned to particular students or groups of students for special investigation. These students may gather their information from such sources as are most convenient and reliable, whether from books, from their parents, or from farmers in the neighborhood. The results of their inquiries should be in substantial accord with the statements below:

(a) Red Clover. This crop is rarely grown alone. Instead it is usually mixed with timothy. The seed mixture is sown, as a rule, with a nurse crop, preferably of wheat, rye or barley. Whether the nurse crop is sown in the autumn or in the spring, the clover should not be put into the ground until spring, as the alternate freezing and thawing are liable to injure or destroy the germinating seed.

The bacteria which are required by red clover are present in nearly all soils so that inoculation is rarely necessary. However, the crop must have limestone in case the soil is found to be acid; and it does not do well if humus is lacking.

The red clover plant rarely lives three years and is regarded as biennial. This makes it fit well into the rotation of crops, which is soon to be considered.

(b) Sweet Clover. Like red clover, sweet clover is a biennial. Owing to this fact, it is not difficult to extirpate it after it has become established in a field, notwithstanding the common belief to the contrary. The methods of culture of this plant are almost identical with those of red clover, except that it may be sown at nearly any time of the year. It will not thrive in an acid soil; and for this reason it will often refuse to grow in a field even though it is found growing as a weed along the roadsides near by.

(c) Alfalfa. In those states west and southwest of the Missouri where alfalfa is found at its best, this crop makes no other special requirement than a reasonably moist seed bed in which the seed may germinate. However, east of the Missouri, it seems rather more difficult for the plant to establish itself; and here it is necessary, as a rule, to take every precaution against failure by increasing the supply of humus in the soil, inoculating with soil either from another alfalfa field or from a field or patch of sweet clover, applying limestone in case the land is found to be acid, and adding phosphorus if this element is lacking. Moreover, it is necessary that the land be thoroughly drained; and ordinarily no nurse crop at all is used. Instead, the ground is plowed immediately after the small grain is harvested, the seed bed is carefully prepared, a dust mulch is maintained by frequent harrowing, and finally the seed is sown in early autumn so that the young plants will have time to become established and to make some growth before winter.

Alfalfa is a perennial; and as it usually occupies the ground for several years, farmers generally feel that they can afford to expend more time and effort in getting this crop started than in starting others.

(d) Crimson Clover. This plant differs from those described above in that it is an annual. It is sown in midsummer, often with cotton or corn when the latter is laid by, makes good growth during the autumn months, lives through the winter, and blossoms in the spring, after which it is usually turned under to enrich the soil.

(e) COWPEAS AND SOY BEANS. These are standard green manuring crops of the South and, like crimson clover, are annuals. They are commonly sown broadcast or drilled in rows in stubble ground after the crop of small grain has been harvested; or sometimes they are planted among the corn or cotton at the last cultivation.

33. Rotation of Crops. We have now reached the point where the class may take up the question of the succession, or order, in which crops should be grown in the soil. Inquire whether it is a good plan to raise any given crop, such as corn, cotton or wheat, on the same land year after year. If the answer is in the negative, call for reasons. While the class will probably agree that it is bad practice to keep the land in the same crop indefinitely, they may not find it so easy to tell just why this is true. There are, however, several important reasons, some of which follow:

(1) If the same crop is grown continuously, the plant food drawn from the soil will come from practically the same depth, or the same soil stratum, year after year; and eventually the store of food elements in this part of the seed bed will become exhausted.

(2) Different crops require different food elements, or if the same ones, then they require them in different proportions. If the same crop is grown year after year, those elements of which it requires most soon become deficient in the soil.

(3) Grain crops as a rule reduce the amount of humus in the soil. If any crop of this kind, then, is grown continuously, the store of humus finally becomes so small as to reduce the fertility in all of those ways of which we learned in our study of soils.

(4) Each crop has its particular enemies in the form of certain insects and diseases; and if it is grown in the same land indefinitely, these pests become established there.

If now the children are asked to name some of the advantages of changing the crops from year to year, the answers will come naturally from the reasons stated:

a. The plant food will not be drawn every year from the same soil stratum.

b. The different plant food elements will be used in more nearly equal amounts.

c. By raising pasture and meadow grasses and legumes frequently, the store of humus can be maintained.

d. Insect pests and diseases are more easily controlled.

e. If legumes are included in the rotation as they should be, they will restore to the soil nearly or quite as much nitrogen as the other crops remove.

(a) ORDER OF ROTATION. Explain to the class that the different crops are ordinarily grown in a certain order, extending usually through four or five years, and that this order is known as a *crop rotation*. Ask, then, that they devise a rotation which they think would be good; and when they have done so, take up and discuss carefully just how the rotation suggested would yield each of the five advantages named above; or if it does not provide for them all, this fact should be made plain and the children should be asked to plan a better one.

There are many rotations which have been found satisfactory. An excellent one, which extends over four years, and which may be used as a model, is as follows:

First year: Corn is raised in ground that has been enriched by turning under a crop of clover.

Second year: Corn.

Third year: Small grain, with which timothy and red clover are seeded.

Fourth year: Timothy and clover. At the end of this fourth season, the sod is turned under, and the land is then ready to begin the rotation again.

GARDEN VEGETABLES AND TRUCK CROPS

34. Warm and Cool Season Crops. The class should be asked to make a list of all the common garden vegetables. When this is finished, have them examine it carefully to determine for what part or parts each of the different kinds of plants is raised. It will then appear that some of them are grown for their roots, some for their stems, some for their leaves and still others for their seeds or fruit.

Inquire if there is any other way in which we might classify these plants besides that given above. A suggestion or two, in case the question puzzles them, will bring out the fact that there is the same difference in vegetables as regards their climatic requirements as there is in the general farm crops which we have studied. Some of them, like oats and wheat, make their best growth during the cool part of the spring but grow poorly after the hot weather of summer comes. These should be planted early and are called *cool season crops*. Others are like corn in that their best growth is made during the heat of midsummer. These are called *warm season crops*. They should not be planted until the ground is thoroughly warm and the danger of frost is past.

If the children are familiar with the different garden vegetables and will now examine their list again, they will discover that the cool season crops are for the most part those that are raised for their roots, stems or leaves, while the warm season crops are chiefly those that are grown for their fruits or seeds—the notable exception to this being peas, which are a cool season crop.

35. Starting and Caring for Cool Season Crops. The cool season crops should now be taken up one by one, and the members of the class asked to learn from their parents or neighbors how each one should be cared for. The results of these inquiries should be substantially as follows:

(a) BEETS. Beets may be sown very early in the spring, the seeds being placed quite close together in the row. The seed bed must be loose and mellow in order that the roots may not be retarded in their growth. After they have attained some size, they should be thinned so that the plants stand six or eight inches apart.

(b) CARROTS AND PARSNIPS. These are like beets in that they should be planted early and should have a loose, mellow seed bed. It is an excellent plan to plant some radish seeds with these crops, as they will both mark the row and break the crust at the surface of the soil, which the little carrot and parsnip plants cannot do readily.

(c) CABBAGE. Cabbage is usually started in the house or hotbed in time that the plants may be set out as soon as the soil is in suitable condition. They can endure considerable frost.

(d) LETTUCE AND RADISHES. These are among the earliest crops to be planted in the spring as both are frost resistant. Like other cool season crops, they grow far better in the spring and in the fall than during the hot weather, which accounts for the fact that it is difficult to have these vegetables for the table during the summer months.

(e) ONIONS. Onions for early use may be grown from sets. For the main crop, however, the seed should be planted early, rather near the surface, and the rows should be marked by a few radish plants sown at the same time.

(f) POTATOES. Potatoes are peculiar in that while they are lovers of cool weather, they can not resist the frost. Hence it is not always easy to tell just when they should be planted. Like the root crops, they require a mellow seed bed. However, the class should understand that the tubers are not true roots, but enlarged, underground stems instead and that the eyes are really buds, such as would produce leaves or twigs on other stems.

(g) PEAS. Peas are of two types — those with *smooth* and those with *wrinkled* seed coats. The smooth peas may be planted with the earliest of the cool season crops, while wrinkled peas should not be planted until about two weeks later. The earlier varieties are usually known as dwarf peas and require no support, while the later ones, as a rule, form vines and should be supported by stakes, brush or wire netting.

36. Care of the Warm Season Crops. None of these crops is able to endure frost. It follows that they should not be planted in the open ground until all danger on this account is past; but since some of them cannot mature their seeds or fruit during the short growing season of the northern states, they are often started in the house or the hotbed and transplanted after the soil has become warm.

(a) TOMATOES. Tomatoes are commonly started in this way in the central and northern parts of the country. They require rich, moist soil; and it is also necessary to see that the spreading vines are not allowed to lie upon the ground, as the fruit often rots. Many growers prune them so that they may be supported by stakes or wires, thus keeping the growing fruit exposed to the sun; and in case the plants tend to form vine rather than fruit, the growing tips are pinched out.

(b) BEANS. Beans are planted in the open ground after the danger of frost is past; and if we wish to raise the Lima beans, we should wait at least two weeks after it is deemed safe to plant other kinds.

(c) SWEET CORN. Sweet Corn is cared for in practically the same manner as is field corn.

(d) SWEET POTATOES. Sweet potatoes are commonly started in the hotbed by planting the potatoes, either whole or split once in two, in sand. When they have attained some size, they are transplanted to ridges in the open garden.

(e) THE VINE CROPS. Vine crops, such as cucumbers, watermelons, muskmelons, pumpkins and squashes, all require rich, well-drained soil; and in the case of watermelons, it should be somewhat sandy.

All of these vine crops are planted in the open ground as soon as the danger of frost is past. However, since it is desirable, in many cases, to give the melons and cucumbers an early start, they are often planted in the hotbed or in the house in cardboard or wooden berry boxes; and later these boxes may be torn away and the plants set out without disturbing their roots in the least.

THE FRUIT CROPS

37. A Peculiarity of Fruit-Bearing Plants. If we should plant an apple seed, would an apple tree grow from it? Doubtless the class will agree that this would be the probable result. Inquire if apple trees are usually started in this way. Perhaps no member of the class can recall ever having seen an apple tree that grew from seed. Why is this?

Questions like these will lead to a most interesting and curious fact relating to fruit-bearing plants. *They do not come true to seed.* If we plant the seed of an Elberta peach, for example, which is one of the finest varieties of that fruit, we may expect a peach tree to grow from it, but *not* an Elberta. Instead, the fruit will usually prove to be altogether different from the Elberta in size, color, flavor and all other characteristics. The same is true of the seeds of practically all other varieties of fruits whether they be apples, pears, plums, cherries, lemons, grapes, or other fruits or berries of any kind.

38. How Fruit-Bearing Plants Are Propagated. We wish to know, of course, when we start a fruit-bearing plant that its fruit will be of the chosen variety. But how is this possible if the plant cannot be grown from seed? Allow the class considerable time to think over this question with the privilege of making inquiries or investigating the matter in any other manner they may choose. Their conclusion, then, should be about as stated below:

In starting a fruit-bearing *tree*, the seed is planted and the young plant is allowed to grow until it is perhaps two or three feet tall. At this stage it is given a new top, either by *grafting* or *budding*, to take the place of its own; and this new top grows firmly to the stem so that the two form a single plant. The top is taken from a tree of the desired variety; and it follows that all fruit that may thereafter be borne on this top will be of this variety.

Fruit-bearing *bushes* or *vines*, such as raspberries, currants, grapes or strawberries, are usually started from *cuttings*, *layers*, *tip layers*, *suckers*, or *runners*.

Directions for propagating plants by the above methods may be secured from the bulletins of the United States Department of Agriculture. In case there is sufficient time for it, they are well worth careful study. Moreover, the children will greatly enjoy the actual work of propagating plants, especially by grafting and budding.

39. Setting the Tree Out in the Orchard. The work of starting fruit-bearing plants as explained in the preceding section is usually done in the nursery. When this work is finished, the young plants are taken up to be transplanted into the orchard. Inquire just how a tree should be set out in the orchard after it has been received from the nursery. It should be remembered that in taking it up, many of the long roots are torn or cut away; and the question for the class to answer is how it may be handled so that it will be injured in the least possible degree by this loss of roots.

Since the leaves depend upon the roots for the plant food and moisture taken from the soil, these cannot be supplied in proper amounts when a part of the root system has been destroyed. It is necessary, then, to remove a corresponding part of the top in order that the two may be kept in "balance." It has been found that this plan greatly reduces the number of trees and shrubs that die when they are transplanted.

40. Why Fruit-Bearing Plants Must Be Pruned. As stated in the last section, pruning begins at the time the tree or shrub is set out; and after this it is necessary at more or less frequent intervals during the entire life of the plant. Indeed the operations of pruning and spraying constitute the greater part of the care of the various fruit crops. Spraying, however, is better studied in the section relating to insect and fungous pests as it merely represents a battle against these enemies of the fruit grower. (See Chapter V, *Enemies of the Farmer*.)

Let us take up first the purposes, or objects, of pruning. Have the class state as many reasons as they can why pruning is necessary. At least six should be given:

(1) To regulate the growth of the tree or vine as regards both size and shape.

(2) To remove unnecessary twigs or limbs, which prevent the sunlight from reaching the inner parts of the tree top.

(3) To remove twigs or limbs which rub against one another, as the wounds caused in this way are liable to admit the spores of disease.

(4) To remove any dead or diseased portions of the plant. In many cases, diseases of both plants and fruit may be controlled in this way.

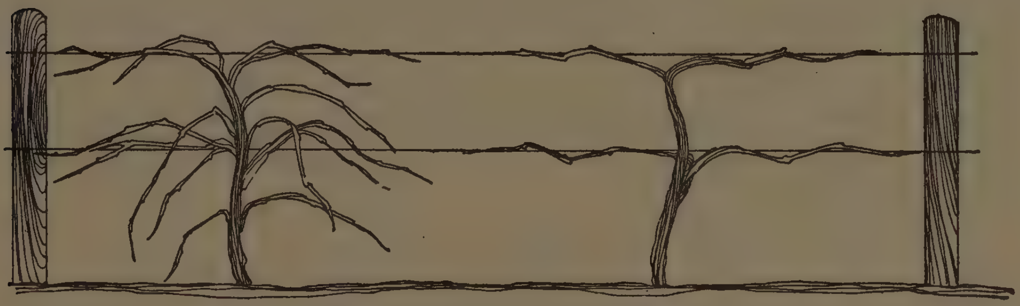
(5) To make the plant more healthy and vigorous in growth. This is the usual result if the pruning is done in the dormant season.

(6) To cause the plant to bear more fruit. Pruning for this purpose is done during the growing season, the aim being to check the growth of the tree, as this results in greater fruit production. This should be done only by one who understands the work, as otherwise the plant may be injured.

41. How the Various Plants Are Pruned. A few of the more important fruit-bearing plants should now be taken up separately and the children should be required to find out by inquiry or otherwise how they should be pruned. Different methods may be given; but all should be in approximate agreement with those given:

(a) APPLE TREE. It is better to begin at the top in pruning the apple tree, removing such of the smaller branches as exclude the sunlight. In this way the top can easily be opened to the light without the removal of any of the larger branches. While doing this, all dead limbs and all rubbing twigs should be removed, as well as all water sprouts. By water-sprouts is meant the long switch-like twigs which bear no fruit. They should be allowed to remain only in case they can be encouraged to grow to some part of the top which is vacant. In this case, they can be cut back to some extent later and will begin bearing fruit.

(b) Peach Tree. Peach trees are not usually pruned unless the fruit buds are found to have been winter-killed. Just before the end of the winter, some of these buds are opened with a knife and examined. If the middles are black rather than green, the buds are dead; and in this case, the main branches are cut back a part of their length. This will tend to cause a more vigorous growth of lateral twigs, upon which the next season's crop of fruit will be largely borne.



TRELLIS FOR GRAPE VINE
This shows how the vine should be pruned

(c) Cherries and Plums. The only rule to follow in pruning these trees is to remove dead, broken and diseased limbs and also those which prevent the sunlight from reaching the inner parts of the top.

(d) Grape Vines. These vines are best grown on a two-wire trellis. In pruning them, one branch is led in each direction on each wire for a distance of two or three feet only. From the buds which may be seen along these branches will grow many new canes, and these will bear fruit *the same season*.

In California and some other regions the vines are cut back until they become self-supporting, and no trellis is used. The vines are planted in rows and are kept about five feet high. They resemble small shrubs.

(e) Raspberries and Blackberries. A peculiar fact about these plants is that soon after the fruit has ripened, the canes which bore it die while new canes begin to grow from the same roots to produce the crop of the succeeding year. In pruning these plants, the old canes are all cut away as soon as the fruit has been gathered in order that they may not interfere with the growth of the younger ones. The following spring, the tips only of these new canes should be pruned off as this favors the development of lateral twigs which will bear fruit.

(f) STRAWBERRY. We do not ordinarily think of the strawberry as a plant that requires pruning. The truth is, however, that it needs it very much, especially while young. The vigor and strength of the young plant should go to the development of a good root system; yet the tendency is for it to produce runners or perhaps even to bear fruit before it has become well established. It follows that the runners and also the blossoms of young plants should be cut away. After this, the runners should not be allowed to enter the spaces between the rows. Rather these should be kept cultivated or mulched. When the plants, then, become old, and the rows matted, the runners may be allowed to take possession of these spaces between them, the old rows may be hoed out, and in this way a new strawberry bed will be easily secured.

COTTON

Use for the study of this plant the "Type Study on Cotton" beginning on page 150. It may be put in here; or it may be inserted just after the treatise on corn instead.

TEST QUESTIONS

1. Why does growing useful plants constitute the greatest part of the farmer's business?
2. What are the three most important crops grown in the United States?
3. What parts of the United States are especially adapted to raising corn? Why?
4. What is gained by testing seed corn before planting it?

5. What crops may be used as substitutes for corn? Where are these crops grown? Why?

6. Compare the uses of wheat and corn. Which crop do you consider the more important? Why?

7. What are the main points of difference between winter and spring wheat?

8. How does the oat plant differ from the wheat plant?

9. In what regions is rye grown? What are its chief uses?

10. What are the essential qualities of a good pasture grass? Of a good meadow grass?

11. Consider the chief causes of failures in growing legumes. How will you present the means of overcoming these failures to your pupils?

12. Why should every farm home have a garden? How can you encourage your boys and girls to help make the garden profitable?

13. What do you understand by the "rotation of crops?" Do you know the rotation commonly practiced in your locality?

14. What are the chief uses of the cotton plant?

15. Can you show your pupils how to set out a tree?

CHAPTER FOUR

FARM ANIMALS

CATTLE

1. Two General Types of Cattle. When we take up the study of any particular class of farm animals, we find that they are raised for at least one specific purpose. In many cases, however, the same species of animal may be raised for two distinct purposes. This is true in the case of cattle. Ask the class what these two purposes are; and then inquire whether those types or classes of cattle which are best adapted to beef production are also best for dairy purposes. If the question proves hard and there is a division of opinion, explain that those cattle that are raised primarily for beef are actually quite different in many important respects from those which are raised for dairy purposes and that they would not ordinarily prove to be satisfactory dairy animals at all.

Perhaps the best way to bring out this difference is to compare a typical cow of one of the best beef breeds with a cow of one of the dairy breeds. Ask the class what important differences they would expect to find if they were to make such a comparison. A little thought will make it clear that the beef cow ought to have much deeper, thicker flesh than the dairy cow, since beef consists of this flesh, while the dairy cow, on the other hand, should be comparatively thin in flesh, owing to the fact that her food is used in the manufacture of milk rather than beef. Following this, the question should be put as to whether the difference in the depth of flesh referred to above would make any noticeable difference in the form or general appearance of the two animals. This point is worthy of thorough discussion, since the children will be able to get in this way a true conception of the fundamental difference between these two important classes of cattle. The final conclusion should be that great depth of flesh would make the entire body appear *thicker*, or wider from side to side, *deeper* from the top of the back downward to the underline, and also *rounder* and *smoother* in general outline — this last being due to the fact that the bony projections would be covered more or less completely by flesh.

In contrast with this, the dairy cow would *not* be so wide or deep in body while her general outline would be rather more *rough* and *angular* owing to the lack of covering of the bony framework.

The above statement holds so generally that the teacher should take pains to see that the children understand both the reasoning and the conclusion thoroughly. It cannot be set down as an invariable rule; yet we know that the cow that is thick in flesh and well rounded in form very rarely proves to be a good milk animal, while the one whose bones are scantily covered with flesh cannot produce good beef.

2. The Beef Types and Beef Breeds. It is not enough that the class understand merely the general distinction between the beef and dairy types of cattle. Each part of the body is modified to some extent by the special purpose for which the animal is raised. In general, these modifications are easily understood and can be reasoned out by the members of the class. Each type should be worked out in this way in some detail. Taking up the beef type first, those questions should be put before the children which will bring out in succession the following points:

(1) In general *form* the beef animal should not be long and rangy nor should it stand up high from the ground. This is due to the fact that animals of the long, rangy kind practically never possess the depth of flesh which beef cattle must have. In form then, the typical beef animal is wide, deep, rather short, and, as experienced cattle breeders say, "blocky."

(2) The *head* is usually short and wide, since this is associated as a rule with the form of body described above.

(3) The *neck* is short and thick for, as we should expect, a blocky animal cannot well have a long neck.

(4) The *shoulders* are smoothly rounded, showing no bony projections, owing to the covering of flesh.

(5) The *back* is *straight, level* and wide; and here again the bony points of the spinal column are not prominent, since they are deeply buried in the thick flesh.

(6) The *ribs* cannot usually be seen. In fact they sometimes can hardly be felt owing to the flesh which covers them.

(7) The *loin*, or that part of the back lying just in front of the hips, is wide and deeply covered with flesh.

(8) The *hips* are not prominent but smoothly rounded, owing to the flesh which envelopes the bony projections.

(9) The *thighs* are full and thickly fleshed well down toward the hock (or knee) joint.

(10) The *twist*, or the region of the crotch between the hind legs, is surprisingly low. This is one of the peculiar characteristics of the beef animal. The legs really seem to have grown together farther down than have those of other animals, owing to the thick masses of flesh that are present.

(11) In general, the *bones* should not be coarse and heavy nor should the *hide* be thick and leathery. We say that an animal whose bone and hide are coarse is of poor *quality* since the meat is almost invariably coarse in texture.

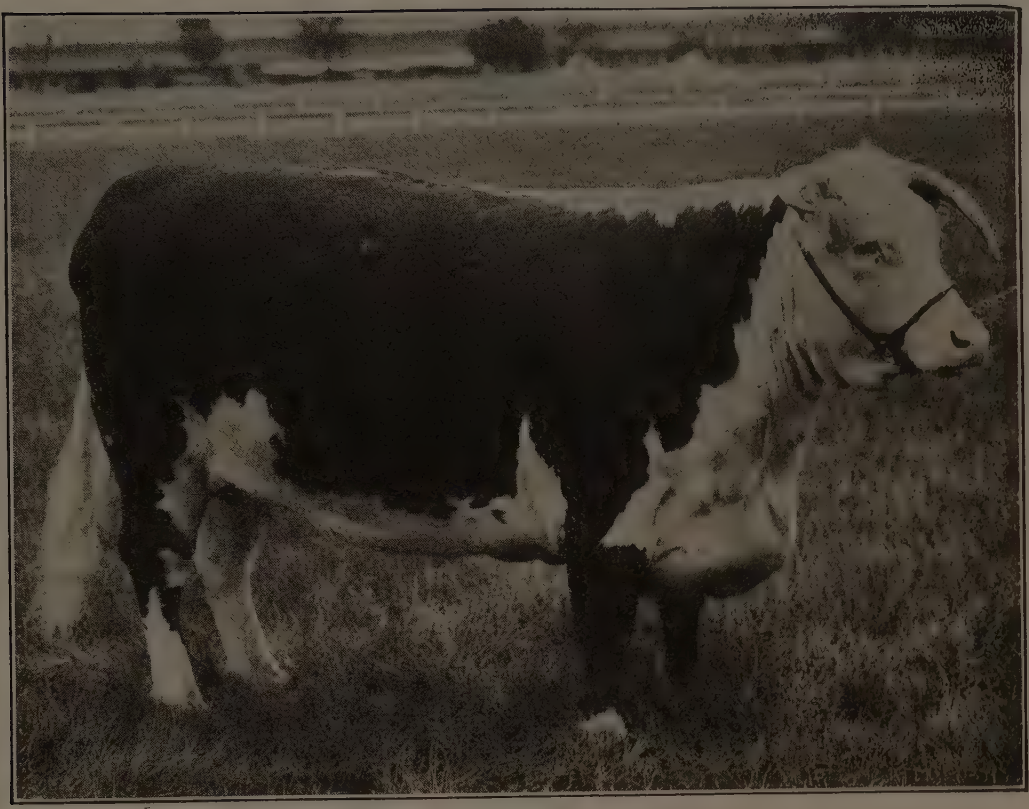
It should be understood that the foregoing description of the characteristics of a typical beef animal applies to every beef breed. The Shorthorn, the Hereford, the Aberdeen-Angus, the Galloway and others may differ in color and certain other minor respects; but all of these breeds represent the result of special efforts on the part of man to produce animals conforming *to the above description*. It follows, then, that the beef type studied above is really the model, or standard, which all breeders of beef cattle are really trying to copy; and the more closely any breed of cattle conforms to this type, the more nearly perfect that breed really is. Let us then take up a brief study of the important beef breeds.

(a) THE SHORTHORN. Ask the class, or certain members of it, to look up the history of this breed and to give it later during recitation. They will find that it had its beginning at a time when our country still belonged to England, the origin of the breed dating from about twenty-five years before the Revolutionary War. Have them refer to a map of Great Britain, if possible, locating the Tees River, which forms the northern boundary of York, the largest county in England. The valley of this river is the home of the Shorthorns, which are descended, for the most part, from the native or wild cattle of ancient Britain. For more than a century and a half, men have been endeavoring, by selecting and mating the best animals, to secure a breed that will conform closely to the beef type.

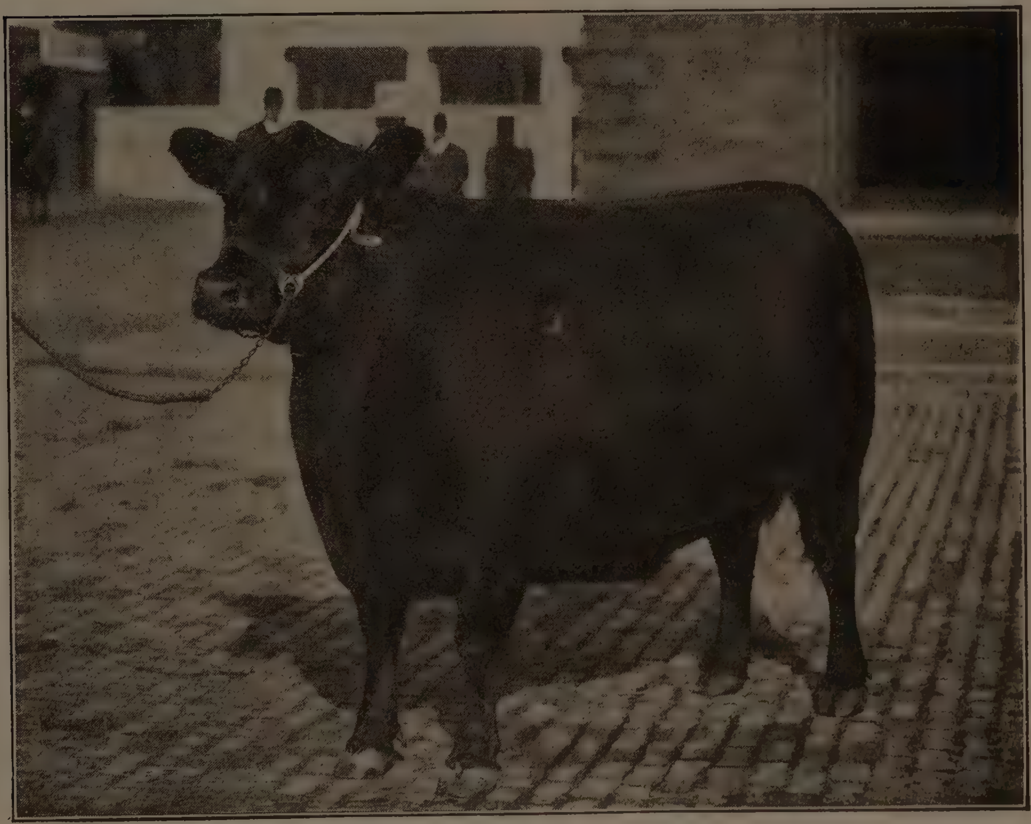
The Shorthorn of today is known as the largest of the beef breeds. It may be roan, red or white in color. It conforms nearly to the ideal beef type and is noted for its mild disposition. It is distinguished from other beef breeds by the fact that the cows exhibit a tendency to give considerable milk. In fact, a number of milking strains of Shorthorns have been originated, perhaps the best known of these being the "Bates bred" stock.

(b) THE HEREFORD. When the class look up the early history of this breed, they will find that it, like the Shorthorn, originated in England, but in the south-western part; that the breed has its beginning at about the same time as the Shorthorns; and that it, too, descended largely from the wild cattle which lived in Britain in early times.

The Hereford is very nearly if not quite as large as the Shorthorn. It is distinguished by its peculiar color markings. The face, the top of the neck, the breast, the legs from the knees and hocks downward, and sometimes the underline of the body are white, while the rest of the body is some shade of red. Like the Shorthorns, the Herefords are a horned breed. They conform quite closely to the beef type though frequently lacking in development of hindquarters. Their special claims to favor lie in their



Hereford Cow



Polled-Angus Cow

BEEF TYPES

ability to fatten at an early age and to make excellent gains on grass alone.

(c) THE ABERDEEN-ANGUS. This is not an English breed but Scotch instead. It developed in the northwestern part of Scotland, the improvement beginning about one hundred years ago. It was evolved chiefly from the wild cattle of Scotland; but no one can say just why the breed has no horns since practically all wild cattle have them.

The most striking differences between the Aberdeen-Angus and the other breeds which we have studied are the absence of horns and the black color. Aside from this, the breed is hardly so large as the others; but it matures early and the meat is of exceptionally fine quality.

3. The Dairy Type and Dairy Breeds. The characteristics of the dairy type, like those of the beef type, become apparent when we consider carefully the particular purpose for which these cattle are raised. We have observed that the dairy cow should not exhibit any tendency to take on flesh, since her food is supposed to go to the production of milk. However, another distinctive characteristic grows out of this one. Milk secretion takes place in the udder and allied organs; and as a result we should expect large development in the rear part of the body.

From these two facts arises the typical conformation of the dairy cow, which experienced dairymen refer to as the triple wedge, or the "three wedges." The first of these wedges is seen from the side, the depth of the body appearing to be greater behind than in front; the second is seen from the rear and above; the body appearing to become wider from the shoulders back to the hips; and the third is seen from in front, the body becoming gradually wider from the top of the shoulders downward rather than round and full as in the case of the beef type.

After this conformation has been discussed, the class should be asked to describe, merely from their own observation or reasoning, the dairy type in the following characteristic points:

(1) The *head* usually appears lean and bony owing to the absence of flesh.

(2) The *neck* is thin and rather slender for the same reason.

(3) The *shoulders* are not smoothly covered but are open and prominent, due to the projecting bones.

(4) The *back* is straight but not wide; and the points of the spinal bones may be easily felt or sometimes the projections may be even seen.

(5) The *ribs* may be seen owing to their being so thinly covered.

(6) The *hips* are prominent, since the bony projections have little or no covering of flesh.

(7) The *thighs* are not well filled but thin, in strong contrast to the full, round thighs of the beef breeds.

(8) The *udder* is large, far larger in fact than that of the typical beef cow. Moreover, it should not be hard and meaty when empty, but extremely soft and flexible.

It should not be understood that all good dairy cows have all of the characteristics named above. However, the best dairy cows conform to this type closely and we know that the leading dairy breeds have improved steadily as they have approached it.

Ask the class now to name the most important breeds of dairy cattle, and to state the characteristics by which each one may be recognized. After this, arrange for different groups of pupils to study up the different breeds, reporting the results in class.

(a) THE HOLSTEIN-FRIESIANS. This breed originated in Friesland in northern Holland, the cattle of this region having been famous for milk and butter production for more than a thousand years. From their native home, they were taken to other countries of Europe; and they were finally brought to the United States both from Friesland and from Holstein, a province of northern Germany.

The Holstein-Friesian cow is a larger animal than most other dairy cows. In color, she is black and white. The breed is noted for its ruggedness and hardihood, as well as for its great capacity for milk production. It holds the world's record for both the amount of milk and the amount of butter fat produced. However, the milk does not contain as high a percentage of fat as does that of some other breeds.

(b) THE JERSEY. The home of this breed is the little island of Jersey, one of the group known as the Channel Islands, which lie off the coast of France but belong to Great Britain. The origin of these cattle is unknown; but the people of the island have long taken a special pride in them and have refused to allow them to become crossed with other cattle of the outside world. More than one hundred fifty years ago, a law was enacted forbidding the importation of any cattle into the island except for the purpose of slaughter. This was before our Revolutionary War; but the law has been rigidly enforced to the present day.

Unlike the Holstein-Friesians, the Jerseys are one of the smallest of the dairy breeds. Indeed, they may ordinarily be recognized by their small size and their peculiar color, which is usually some shade of fawn. They are noted for their beauty and refinement; but their great claim to favor lies not in this but in the high percentage of butter fat which their milk contains.

(c) THE GUERNSEY. This breed originated in the islands of Guernsey and Alderney of the Channel Island group. The origin of the breed is unknown, though it is generally supposed that the foundation of all of these Channel Island cattle came from the neighboring mainland of France. At any rate the island of Guernsey, more than one hundred years ago, followed the example of Jersey Island in forbidding the importation of cattle from other countries except for purposes of slaughter.

Guernsey cattle are of medium size. Their color is brownish yellow or reddish fawn with white markings. The cows not only have a large milk-producing capacity, but are noted for the length of time during which they hold their flow of milk. The milk contains a high percentage of butter fat; but it is distinguished from that of other breeds by its rich yellow color. This color is not due to the cream which the milk contains. Indeed, Guernsey milk is usually more yellow after the cream has been skimmed from it than is that of other breeds before skimming.

(d) THE AYRSHIRE. Like the Aberdeen-Angus, this is a Scotch breed. Its name is derived from the county of Ayrshire in the southwestern part of that country. It is believed to have originated by the crossing of several other breeds upon the native cattle of that region a little more than a century ago.

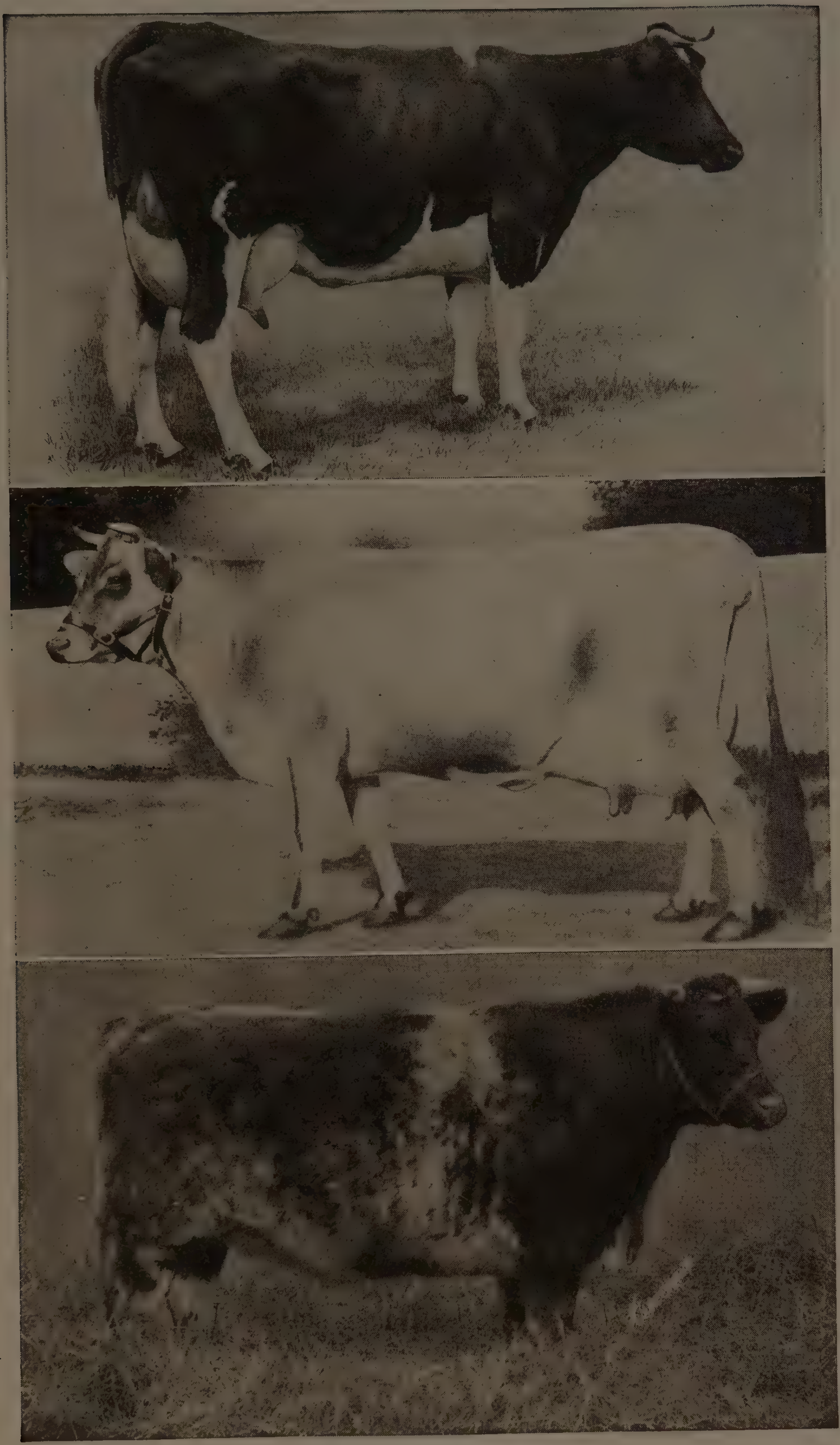
Ayrshire cattle are medium in size. Their color varies, with red, brown and white predominating. They are easily recognized by the length and shape of their horns which curve outward and upward, often turning back slightly at the tips. They show some beef-producing tendency; and the covering of flesh makes them somewhat smoother and less angular than the other dairy breeds. In milk and butter fat production, they fall somewhat below the other dairy breeds that we have studied.

4. The Feeding of Animals. Introduce this topic with a question as to what use animals make of the food that they eat. It may prove difficult for the class to make a definite answer, in which case they should be allowed time to think it over. After this, their reply should be that the two chief purposes which food serves in the animal body are as follows:

(1) It provides *heat* — which is a form of energy — as well as *all other energy* necessary for muscular motion and to carry on the processes of life.

(2) It provides material *to build up the tissues* of the body as fast as they are worn out and broken down.

To make this twofold function of food perfectly clear, ask in what respect the food taken into the body differs in its effects from the fuel that is placed beneath the boiler of an engine; and the answer given to this question should be



HOLSTEIN-FRIESIAN COW
JERSEY COW
SHORT-HORN COW

that while the fuel beneath the boiler provides heat and also the energy to produce motion, just as does the food, the great difference between them lies in the fact that the fuel does *not* repair the wear and tear nor rebuild again the broken-down parts of the machine.

Inquire then as to whether all foods perform both of these functions, or whether they are really performed by different classes or kinds of foods. In this way three important facts below are brought out. They are:

(a) There are three important classes of foods; *i.e.*, *carbohydrates*, *fats* and *oils*, and *proteins*.

(b) The carbohydrates and fats and oils produce the *heat* and *other energy* required by living animals; and if they are fed *in excess*, they are stored in the animal's body in the form of fat. It is in this way that cattle and other animals are fattened.

(c) The proteins *rebuild* the worn-out and broken-down tissues.

5. Kinds of Feeds for Beef and Dairy Cattle. Ask the children to name several feeds that are given to cattle. No matter what the answer may be, inquire then if any one of the feeds named consists of pure carbohydrates, pure fats and oils, or pure proteins. The discussion should bring out the fact that there is practically no feed which consists of these food materials in a pure state. Rather, they are mixed in proportions which vary surprisingly in the different feeds; and the successful feeding of animals depends in a large measure upon the combining of the feeds in such a way that the animals receive the heat-producing material and the tissue-building material in the right proportions. This is known as the *balancing of rations*.

In determining how the ration may be balanced for any class of animals, it is of course necessary to know the percentage of carbohydrates, of fats and oils, and of proteins in each of the feeds used. In the list below will be found the percentage of each of these materials in each of sixteen common feeds given to cattle:

KIND OF FEED	Percentage of Carbohydrates	Percentage of Fats and Oils	Percentage of Proteins
Shelled Corn	66.8	4.3	7.8
Oats	49.2	4.3	8.8
Barley	65.3	1.6	8.4
Wheat Middlings	45.7	4.5	13.0
Wheat Bran	42.0	2.5	11.9
Kafir Corn	44.3	1.4	5.2
Oil Meal (Old Process)	32.0	6.9	30.2
Oil Meal (New Process)	35.7	2.4	31.5
Cottonseed Meal	21.4	9.6	37.6
Timothy Hay	42.4	1.3	2.8
Red Clover Hay	37.8	1.8	7.1
Japan Clover Hay	37.7	1.4	9.1
Alfalfa Hay	40.5	0.9	10.5
Corn Stover, or Fodder without Ears	31.2	0.7	1.4
Oat Straw	39.5	0.8	1.3
Corn Silage	14.2	0.7	1.4

6. How Rations of Cattle Are Balanced. Before taking up the question of how to balance rations for animals, it will be necessary to explain to the class the meaning of the terms *carbohydrate equivalent* and *nutritive ratio*, since they are in general use and of considerable importance.

We have observed that both the carbohydrates and the fats and oils have the same effects when fed to animals. It is known that a given amount of any fat or oil will produce about 2.25 times as much heat and other energy as will the same amount of carbohydrates. It follows that if we multiply the amount of fats and oils present in any feed by 2.25 and add this to the amount of the carbohydrates present, the sum will represent the value of the feed *in carbohydrates alone*; and this is known as the *carbohydrate equivalent* of the feed. It is simply the total heat-producing food present, expressed in terms of carbohydrates.

The ratio of the protein present to the carbohydrate equivalent is called the *nutritive ratio*.

To make certain that these terms are understood, ask the class to determine the nutritive ratio of shelled corn from the analysis given above.

In each one hundred pounds of this feed, the amount of fats and oils is 4.3 pounds. This is multiplied by 2.25, the product being approximately 9.7. When this amount is added to 66.8, it gives 76.5 for the carbohydrate equivalent. To determine the nutritive ratio, we divide this by the amount of proteins present, or 7.8 pounds. This gives 9.8; and so we say that the nutritive ratio is 1 : 9.8, by which we mean that shelled corn contains 9.8 parts of heat-producing materials for each part of tissue-building material.

Inquire now what animals should have the higher proportion of proteins in their feeds — young ones or old ones. The class should easily reason to the conclusion that since young animals are growing and building new tissue in addition to that which is worn out, they would need a larger proportion of proteins in their feeds than do adult animals which have only to repair that which is broken down. This shows why it is that experienced cattle feeders find it necessary to give calves and young growing animals a ration whose nutritive ratio is perhaps 1 : 4.5 or 1 : 5, while as soon as they have attained their full growth, a nutritive ratio of 1 : 7 or 1 : 8 will give satisfactory results, save in the case of cows giving milk or animals that are being fattened, both of which need more proteins.

(a) Problems. An extremely interesting line of work may be introduced at this point by asking the class to figure out rations, such as would be used in practical cattle feeding.

Suppose, for example, that a farmer wishes to fatten some cattle for the market and has shelled corn, corn silage and alfalfa hay to feed them. He knows that the nutritive ratio should be about 1 : 6; and the problem is to find out in what proportion these feeds should be given in order that the nutritive ratio would be right. The class will have to do just what the farmer has to do; that is, they must combine the feeds in different proportions until they find one that gives approximately the correct nutritive ratio.

For our first trial, let us see how it would be to feed with each one hundred pounds of corn one hundred pounds of silage and fifty pounds of alfalfa hay. From the compositions of these feeds which have been given above, we can easily test this ration in the following manner to see if it will be satisfactory:

	Carbohydrates	Fats and Oils	Proteins
100 lb. Corn contain..........	66.8 lb.	4.3 lb.	7.8 lb.
100 lb. Silage contain.........	14.2 lb.	0.7 lb.	1.4 lb.
50 lb. Alfalfa contain........	20.2 lb.	0.4 lb.	5.2 lb.
Total ration contains.......	101.2 lb.	5.4 lb.	14.4 lb.

These figures are taken from the analyses that have been given in the table on page 90. If we now multiply the amount of fats and oils by 2.25, we get 12.1; and when this is added to the amount of carbohydrates, the carbohydrate equivalent is found to be 113.3. The amount of proteins, 14.4 pounds, is contained in 113.3 approximately 7.8 times. Hence the nutritive ratio of the entire ration is 1 : 7.8, which is quite wide of the mark and will not do at all. By inspecting the figures, however, we see that the amount of proteins is too small in proportion to the carbohydrates; and from this, it is apparent that the ration may be remedied either by increasing the amount of alfalfa, which is the feed containing the highest percentage of proteins, or by decreasing the amount of corn or of silage, which contain a high percentage of carbohydrates. With this in mind, another ration should be made up and tested in the same way; and this should be continued until one is finally found that gives approximately the right nutritive ratio.

The teacher can easily devise other problems of this kind, making use of other feeds. The value of this work is at least twofold; it emphasizes the need of a sufficient amount of proteins in the ration and it requires that the pupils become in some degree familiar with the composition of the various feeds.

7. How Beef Cattle Are Raised. It is a good plan to have the class make an investigation of the methods used by the various farmers who raise beef cattle in the community. It will usually be found that two different plans are being followed, some farmers purchasing cattle for feeding purposes from the large markets or from their neighbors instead of raising them, while others raise their own young stock and prepare it for the market.

Those who purchase from the large markets usually get animals that were raised on the western ranges but could not be fattened there because of the lack of grain. This supply of cattle for feeding, or *feeders*, as they are called, is diminishing steadily, owing to the breaking up of the ranges; and this in turn is making it more and more necessary for farmers who wish to produce beef to raise their own feeders.

Of the men who are following the latter plan, many are producing what is known as *baby beef*. For this, cows of the best beef breeds are used. However, these cows are not ordinarily milked as are dairy cows. Instead, the calves are allowed to run with them for several months. These calves, then, have a diet of milk in addition to pasture and other feeds. The result is that they make very rapid growth and are easily prepared for market at an early age, the process of fattening not being difficult, owing to the fact that they have not been allowed to lose their *baby fat*.

8. The Care of the Dairy Cow. The class should be asked to what extent the amount of milk given by a dairy cow depends upon the amount of food which she receives. All will agree that an insufficient amount of food will reduce the milk production. Inquire, then, whether the amount of milk given bears any relation to the nutritive ratio of the cow's ration. The answer to this important question may not be clear at first. If the cow is giving only a little milk, the ration required will be not greatly different from that necessary for simple maintenance; but since milk, itself, contains a high percentage of proteins, it is apparent that the amount of proteins in the ration must increase greatly as the amount of milk produced increases. Thus, the correct ration for a cow giving eleven pounds of milk per day is one whose nutritive ratio is about 1 : 6.7. For a cow yielding twenty-two pounds of milk per day, the nutritive ratio should be about 1 : 5.7; and if a cow yields milk weighing 27.5 pounds per day, the nutritive ratio should be 1 : 4.5.

To illustrate how this works out in actual feeding, ask the pupils to balance a ration for cows yielding each of the above amounts of milk per day, using in each case, the same feeds.

9. Building up the Dairy Herd. One of the most difficult problems of the dairy business is that of ridding the herd of cows which return little or no profit.

How can we tell whether a cow is profitable or not?

Allow the children to discuss this fully. The truth is that it cannot be determined accurately save by weighing and testing the milk carefully and keeping at the same time a record of the amount of feed which the cow consumes.

Very many dairymen make it a regular practice to weigh the milk from each cow at each milking. If, then, the average percentage of butter fat in the milk of each cow is known, it becomes an easy matter to figure the number of pounds of butter fat given by each one during the year; and when the value of the feed consumed is deducted from the value of this butter fat, the exact profit made by every cow is known. The next step is, of course, the elimination of the least profitable cows from the herd, their places being filled by better ones. Modern dairying is coming more and more to rest upon this practice for increasing the profitableness of the dairy herd.

HORSES

10. Two Types of Horses. As in the case of cattle, the first topic to be taken up in the study of horses is that of types. The class will be able to make the general classification as heavy, or draft, horses and light horses, such as are used for driving or riding purposes. Following this, ask them to describe the draft-horse type as they have it in mind. It is not expected that their information will be very definite on this point but rather that by comparison of ideas, the main characteristics of the draft type will be gradually brought out.

11. The Draft Type. The draft type of horses corresponds very closely to the beef type of cattle. The body is wide, deep and massive and the legs short. Since power is desired rather than speed, we may say that the distinguishing characteristic of the draft horse is a heavy muscular development throughout. Next after the low-set blocky form, weight is considered most important. To be regarded as a draft horse at all, it is necessary that the animal weigh fifteen hundred pounds; and it is not eligible to the heavy draft class unless its weight exceeds eighteen hundred pounds.

Ask the children to name as many breeds of draft horses as they can and to explain as fully as they are able how the different breeds *may be recognized.* The latter may prove difficult but will be made plain later when the breeds are taken up separately. To this end assign to different students or groups of students certain breeds for study, asking that they give a brief history as well as a description of the characteristics of each breed before the class. These reports should be about as follows:

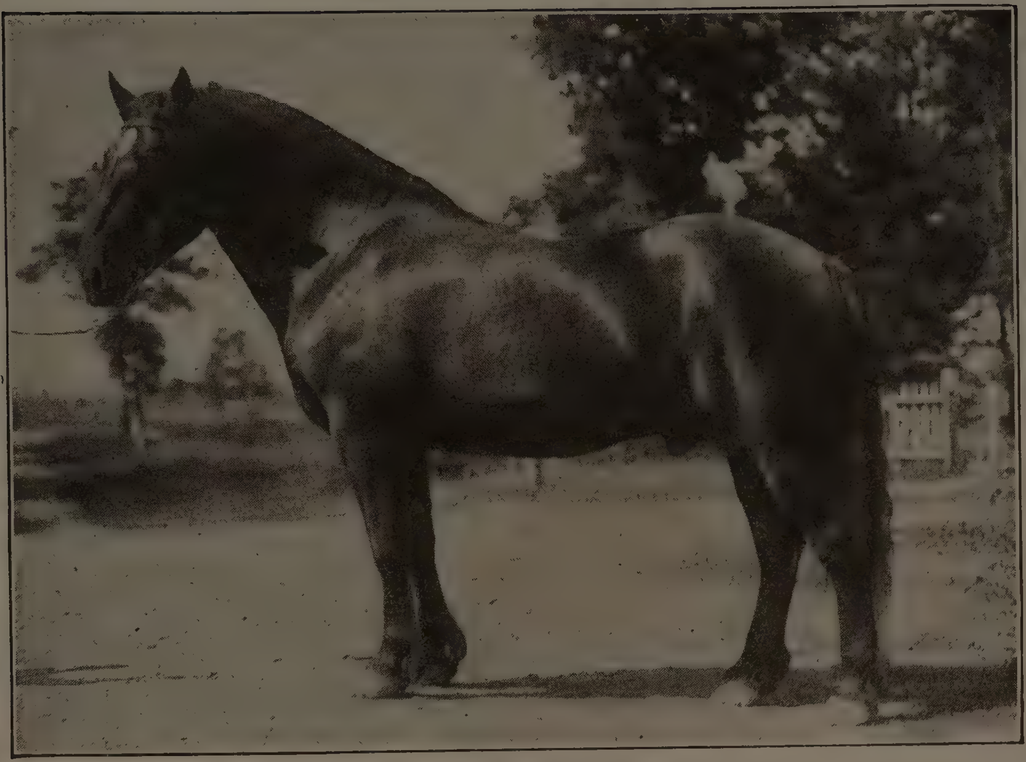
(a) THE PERCHERON. This breed originated in France, particularly in the region known as La Perche. For two or three centuries, or perhaps longer, the horses of that region have been famous. About a century ago, two stallions, Godolphin and Gallipoli, were imported into France from the East by the French government; and the beauty and excellence of the breed is believed to be due largely to the fact that most Percherons now contain blood of these two horses.

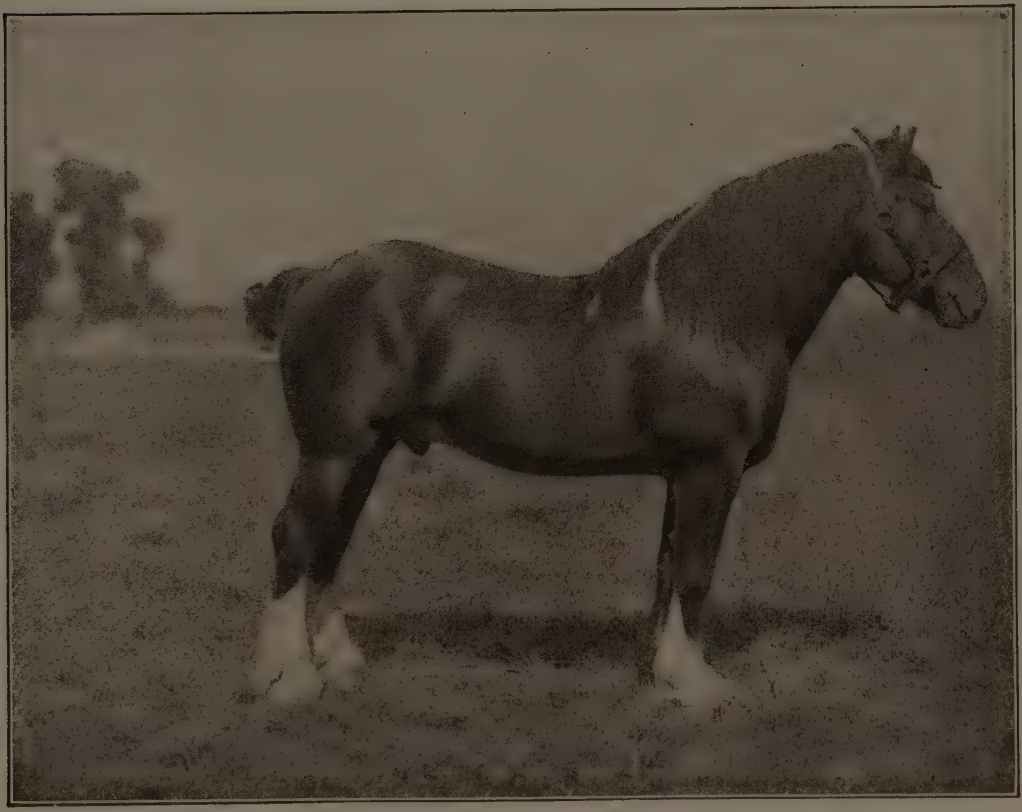
The Percherons are usually gray or black in color. They are second to none in size; yet they are noted for their beauty and style. The backs of their legs, below the knees and hocks, do not have a growth of long hair as in the case of some other draft breeds; and this cleanness of limb contributes much to the neat, trim appearance of the animal.

(b) THE CLYDESDALE. Clydesdales had their origin in Scotland, the home of the Aberdeen-Angus cattle. Their native home is the valley of the river Clyde, whence the name. This region, like La Perche in France, has long been famous for its heavy horses, though the breed as we know it is to be regarded as the result of crossing these horses with others taken to Scotland from England.

The Clydesdales are practically equal in size to the Percherons, but otherwise the two breeds have few points of resemblance. In color the Clydesdale is usually bay or brown with white in the face and with one or more white feet. The nose is often somewhat Roman. On the backs of the legs below the knees and hocks, is an abundance of long hair, usually known as "the feather." The body is generally rather longer than that of the Percheron and not so heavy and massive; and since the legs are longer, the Clydesdale is somewhat taller. It is believed by many to have the smoothest and most graceful action of any of the draft breeds.

(c) THE SHIRE. The lowlands of England, particularly Lincolnshire and Cambridgeshire, are the home of the Shire. Many centuries ago, horses from this region were much prized for war purposes because of their remarkable size and strength. At one time or another, the Shire has been known as the Giant Lincolnshire, the War Horse, the Great Horse, the Old English Black Horse and the Strong Horse.


Percheron Stallion


Clydesdale Stallion

The Shire has practically the same color markings as the Clydesdale, and even a heavier feather on the legs; but in other respects the resemblance is not so strong. The Shire is low-set, like the Percheron, rather than tall, like the Clydesdale; in fact, in massiveness of body, the Shire probably surpasses the Percheron. However, it tends to be rather awkward and clumsy in action, both the Percheron and the Clydesdale excelling it in this respect.

(d) THE BELGIAN. Another country whose horses have long been famous for their size and quality is Belgium. Even the government of that nation has for many years given special encouragement to the breeding of superior horses; pensions, or bounties, being given to the owners of the best horses throughout the kingdom. The result has been that the horses of the entire nation have steadily improved until the standard of excellence has risen far above that of most other countries. The breed of horses, which is known as Belgians, has, then, been developed by a nation rather than by the breeders of any locality.

The Belgian horse is perhaps the most blocky of any of the draft horses. In proportion to its size, its body is wider and deeper than that of others. In color, there is much variation, bays, blacks, browns, chestnuts, grays and roans being frequently seen. The lower legs are nearly or quite clean of feather.

12. The Light Type of Horses. Ask the class to name as many points of difference as they can between the draft type and the light type of horses, such as are used for driving and riding purposes. Even though they may not have thought over the question before, they will be able to give some of the distinguishing characteristics of the two types.

The light type of horses are not so deep and wide in body as the draft type, but instead they are longer, less heavily muscled and not so low-set. If we compare the roadster, or the saddle horse, with the typical draft horse, we cannot help observing that the legs seem longer, the body higher from the ground, and that the entire animal is built on a much lighter scale. This at first appears to be the chief difference between the two; but another very important difference is in the action, or gait, of the two animals. A draft horse looks awkward and clumsy when drawing a carriage or when used as a saddle horse, because of his slow, shambling gait; and it is true that among light horses, which are used for special purposes, as most of them are, the action is considered in many cases to be as important as the form of the animals.

It is probable that the class will be less familiar with the breeds of light horses than with the draft breeds. If so, and if it is found difficult to secure information concerning them, the teacher may give the particulars relating to several of the breeds, requiring the class to reproduce the facts in written form later.

(a) THE THOROUGHBRED. The term *Thoroughbred* refers to a particular breed of horses; and its use to indicate any other kind or class of live stock is, in the opinion of most well-informed breeders, incorrect.

The Thoroughbreds are the breed of running horses that have made this kind of racing popular in England. The breed was developed in England by crossing the swiftest of the native horses with imported horses, chiefly from the East. For more than a hundred years, it has been kept pure, during which time it has won unquestioned supremacy among the running horses of the world.

The Thoroughbred is a small horse, rarely weighing more than one thousand pounds. It is narrow, but still deep in chest; and the hindquarters are long and strongly muscled, which accounts for the remarkable speed of the animal. The color is generally bay or brown.

(b) THE AMERICAN SADDLE HORSE. This name also refers to a particular breed of horses. It was originated, for the most part, in the states of Virginia, Kentucky, Tennessee, and Missouri; but since Kentucky led in the development of the breed, it is often spoken of as the Kentucky Saddle Horse. Thoroughbred horses were used extensively in establishing and improving this breed.

The American Saddle Horse is larger than the Thoroughbred, usually standing from three to four inches taller and weighing about one hundred pounds more. Its color is bay, brown or black. It is a much more beautiful animal than the Thoroughbred while it is regarded as the most stylish and graceful horse in the world.

(c) THE STANDARDBRED. This is another American breed of horses; and, as in the case of the American Saddle Horse, Thoroughbred horses were extensively used in its development. Like the Thoroughbred, the Standardbred was evolved for the sole purpose of speed,—not in running, however, but in either trotting or pacing. In fact, the Standardbred may be styled the trotting horse of America, just as the Thoroughbred is spoken of as the running horse of England, though it is true that Standardbreds often pace and are easily the world's swiftest horses at this gait as they are also at trotting. It is to be noted that the most famous horse that has ever been reared in America belonged to this breed. His name was Hambletonian 10. He lived during the middle part of the last century, dying in 1876. His fame rests upon the remarkable speed shown by many of his descendants rather than upon his own.

The Standardbred is bay, brown or black in color. It is somewhat larger than the American Saddle Horse and considerably larger than the Thoroughbred. It lacks the beauty and grace of the American Saddle Horse, everything being sacrificed for the long, straight, swift stride which has won for these horses the supremacy over all other breeds at their chosen gaits.

(d) THE HACKNEY COACH HORSE. This breed of horses, as well as those which follow, was developed not for speed but for heavy carriage work, particularly about the cities. For this work, considerable size and strength are needed; but more than this, it is desired that the horse be very stylish in action.

The Hackney was developed in Norfolk and Yorkshire in England. Horses from Arabia, Turkey and northern Africa were imported and crossed upon native English horses, and the Thoroughbred was also used in this way in developing the Hackney.

This horse usually weighs between one thousand and twelve hundred pounds. Its color is chestnut. It is much heavier in body than are the racing breeds. Its distinctive characteristic is the remarkably high yet exceedingly stylish action of knees and hocks. In this extreme style of action, the Hackney has no rival among the other horses of the world.

(e) THE FRENCH COACH HORSE. This breed owes its origin chiefly to the crossing of the Thoroughbred with Percheron draft horses. Like the Hackney, it was developed for utility rather than for racing purposes.

The French Coach horse is bay, brown or chestnut in color. It is a larger horse than the Hackney, weighing usually from 1200 to 1350 pounds. It lacks the stylish action of the Hackney, its stride being straighter and longer but not so high.

(f) THE SHETLAND PONY. The study of the breeds of horses should be made to include at least one or two of the pony breeds. The most popular of these is the Shetland. Require the class to look up the history and also the peculiar characteristics of these diminutive horses. A summary of the results should include most or all of the facts here given:

The native home of the Shetland pony is the Shetland Island group, which lies about two hundred miles northeast of Scotland. This group consists of many small islands, but only five or six of them are inhabited.

The people of the Shetland Islands have raised these ponies as far back as history or tradition runs. However, since the islands are small and only a few of them are inhabited, the total number of ponies living there would probably not exceed two or three thousand. The people of the United States are raising many more Shetland ponies than are the people of the Shetland Islands, at present.

The Shetland pony is probably the hardiest as well as the smallest horse in the world. Its small size is due to constant hardships and a scant amount of feed so long continued that the entire breed has become dwarfed. When brought to our country and allowed sufficient feed, each generation tends to become larger than the one before; and so American breeders of these ponies have to be on the lookout constantly lest their ponies become larger than the market demands.

The Shetland pony should not stand more than forty-two inches high to the shoulder tops, or withers; and its weight should not exceed four hundred pounds. In form it should be similar to the draft type rather than the light horse type.

13. Unsoundnesses of Horses. The value and usefulness of a horse depends very largely upon whether it is sound or not; and since horses are subject to so many unsoundnesses, it is important that some of the most common ones be studied. All owners of horses are greatly interested in this subject and it is probable that even the children will be found quite well informed concerning it.

Ask, then, that they name as many unsoundnesses as they can. By unsoundness is meant any defect that interferes with or is liable to interfere with the animal's usefulness; and so mere blemishes which only mar the beauty or detract from the appearance of the horse should not be included in the list. This list made up by the children should include most or all of the unsoundnesses named in the following paragraphs. After the class has completed it, ask them to find out just what each one is and how it may be detected, making inquiries of their parents or any one else they choose.

(a) DEFECTIVE BREATHING. Defective breathing, or as it is sometimes called, *poor wind*, may be detected by leading or driving the horse rapidly up hill. When stopped, it should take three or four long breaths and then return to its normal breathing. If, instead, it makes peculiar sounds when it inhales, it is said to roar, whistle, or rattle; but if the sound is made with exhalation, it is said to have the *heaves*.

(b) Poll Evil. This is a disease of the top of the head. If the region between the ears is rubbed or pressed, it will be found to be very tender if the trouble is present, and sometimes more or less swelling will be discovered. Any soreness at all in this part is regarded as serious, as the disease is a very difficult one to control or cure.

(c) Impaired Sight. In many cases actual blindness can be detected by the appearance of the eye; but this is not always true. If the hand is held at one side near the head and moved as if to strike the horse, it will sometimes be found that the animal cannot see it. Approaching blindness, which is of course nearly as serious, is much harder to detect. A thin, almost invisible whitish coating over the upper part of the pupil, which is called a cataract, may indicate this; and if the eye tends to be round, or spherical, rather than elliptical in shape as it should be, disease may be suspected.

(d) Fistula. A fistula is a running sore about the shoulder, caused by a deep bruise or other injury, which has become infected and which Nature seeks to drain by a peculiar tube leading to the surface. The fact that it is so deep-seated and so persistent makes it a very serious unsoundness.

(e) Sweeny. Sweeny is a wasting away of the muscles which cover the shoulder blade. Instead of being full and round, the affected part becomes flat or even may seem hollow when compared with the other shoulder.

(f) Splints. Splints are bony growths usually on the front legs and on the inner sides below the knees. If they are large and near the knee joint, they are regarded as an unsoundness; but if farther down and only of moderate size, they are considered merely as blemishes.

(g) RING BONE. The sloping part of the foot just above the hoof is known as the *pastern.* Sometimes a bony growth forms entirely, or at least partly around the pastern beneath the skin. This is known as *ring bone,* which is one of the most serious of all unsoundnesses.

(h) SIDE BONE. At the top of the hoof on each side is a strong cartilage leading up into the pastern. These cartilages sometimes ossify, or turn to bone. When pressed with the fingers, they feel like bony enlargements just beneath the skin. Like ring bone, they are regarded as one of the most serious unsoundnesses.

(i) BONE SPAVIN. The hock joint, which is the one corresponding to the knee but on the hind leg, probably receives more attention than any other part of the animal by people who are examining strange horses. This is due to the fact that five serious unsoundnesses are found in or near this joint. The first of these is *bone spavin,* which is a bony enlargement on the inside, front, lower part of the hock joint. It produces lameness and greatly interferes with the horse's action.

(j) BOG SPAVIN. This is a soft enlargement which appears at about the same place as the bone spavin.

(k) OCCULT SPAVIN. This is invisible from the outside, being due to a deposit of bone in the joint, itself, the latter being stiffened and permanent lameness resulting.

(l) THOROUGHPIN. Behind the hock joint and just above it, a soft enlargement, or swelling, sometimes occurs between the large tendon and the bone. It is called *thoroughpin.* It may be easily recognized, since it may be pushed through from side to side with the fingers.

(m) CURB. This unsoundness is also behind the hock joint but just below it. It is a hard, bony enlargement on the rear surface of the bone.

14. Feeding Horses. The ration that should be fed to horses depends chiefly upon the amount of work that they are doing. The nutritive ratio for a horse doing very light work should be about 1 : 7; for one doing medium work, it should be 1 : 6.2, and for one at heavy work, it should be 1 : 6.

The table contains feeds usually given to horses, together with the percentage of digestible carbohydrates, fats and oils and proteins.

KIND OF FEED	Carbohydrates	Fats and Oils	Proteins
Oats	49.2	4.3	8.8
Corn	66.8	4.3	7.8
Wheat Bran	42.0	2.5	11.9
Wheat Middlings	45.7	4.5	13.0
Timothy Hay	42.4	1.3	2.8
Red Clover Hay	37.8	1.8	7.1
Alfalfa Hay	40.5	0.9	10.5
Corn Stover	31.2	0.7	1.4
Hay from Mixed Grasses	42.0	1.3	4.2

FEED FOR HORSES. By way of variation from the plan previously used in calculating rations, ask each member of the class to figure out at least three different ways of combining feeds from the above list so that the nutritive ratio shall be approximately correct for horses doing heavy work and so that the amount of hay or stover included in the combination shall be equal to or greater than that of the oats.

SWINE

15. Two Types of Swine. In our study of cattle and of horses as well, we have found two distinct types, differing from each other in many important respects. The same is true of hogs; and as in the case of cattle and horses, the differences are due solely to the different purposes for which the animals are raised.

What are the two purposes for which hogs are raised? All, of course, are used for food; but the difference lies in the fact that some people use the flesh chiefly in the form of bacon and require that it contain a large proportion of lean meat, while others prefer much lard and so require a much higher proportion of fat. The two types of swine, then, are the lard, or fat-hog type, and the bacon type.

16. The Lard Type. This is the type with which the class will probably be most familiar since it is the one chiefly raised in the United States. A full discussion of it should be allowed especially if one or more members of the class are found to be quite familiar with it. The description of the type follows:

The body of the animal is very wide and deep. The width should not taper toward the rear but should be nearly as great through the hindquarters as through the shoulders. The lard hog is of only medium length; otherwise the weight resulting from the great amount of fat which it takes on tends to cause a weakness of the back which should be straight or slightly arched instead. The legs are short. The hams should be well filled, carrying flesh well down toward the hocks. The joints and bone should not be coarse and heavy. Neither should the hair be coarse; and the skin should be comparatively free from wrinkles.

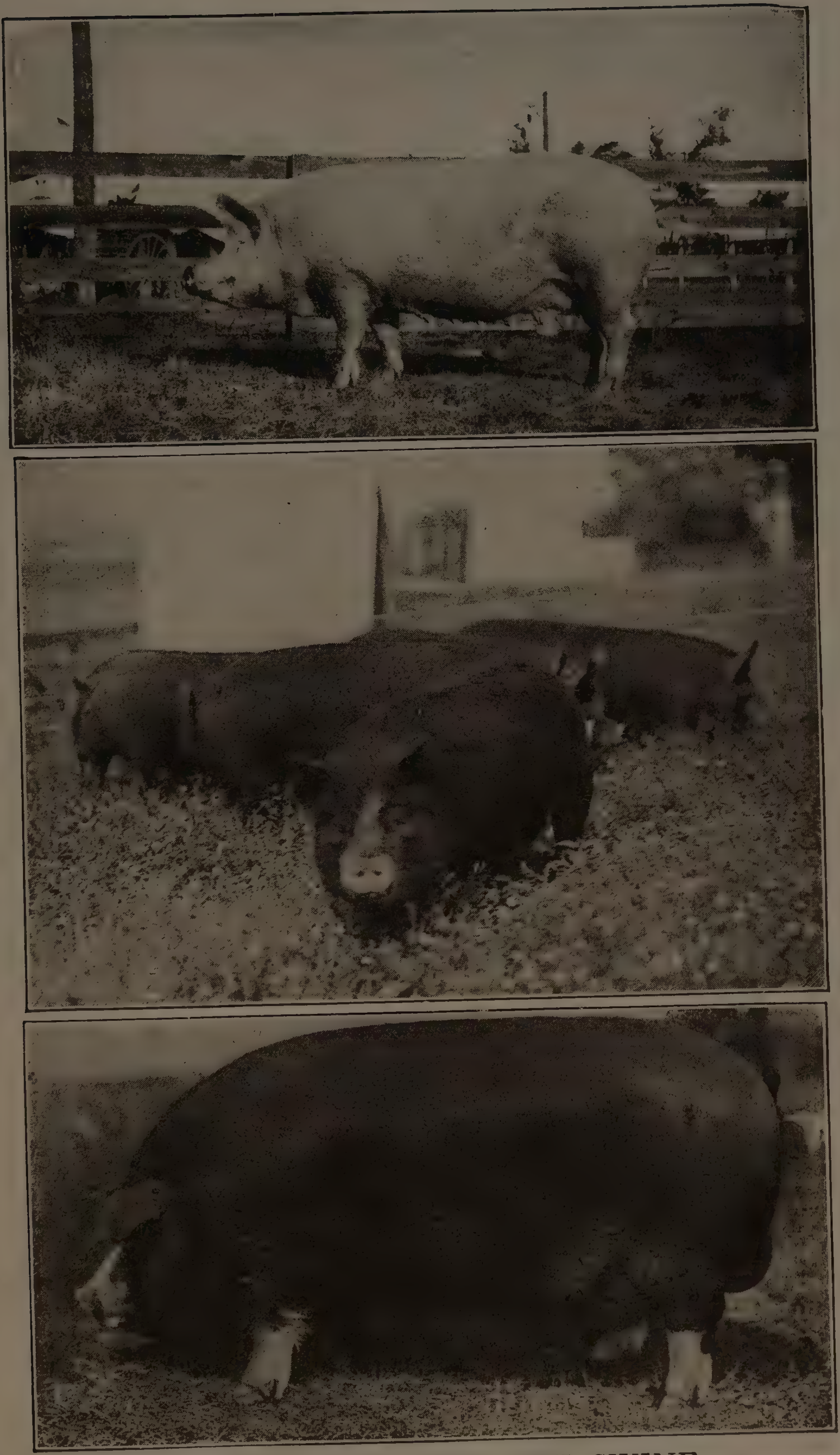
17. Breeds of Lard Hogs. Most of the breeds of hogs raised in the United States belong to this class. The pupils should be able to name the most important ones; and after they have done so, they should be asked to tell as far as they are able how each breed may be recognized. This will not prove easy; for even though one is able to recognize any particular breed, it is still quite difficult, as a rule, to name its actual characteristics. After the pupils have given all the information they can along this line, assign to certain ones the task of looking up and reporting upon the history and characteristics of particular breeds.

(a) THE POLAND CHINA. All the breeds of farm animals so far studied, with the exception of two breeds of light horses, have had their origin in other countries than our own. The Poland China hog was developed in America. Its home is the valley of the Miami River in southern Ohio. Moreover, its evolution seems to have begun soon after the Indians were driven out of that country. It is even true that the founding of the breed was an indirect result of the settlement of that section by white people after the expulsion of the Indians, for these settlers brought with them hogs of several different kinds and it was by the crossing and blending of these that the Poland China was developed.

The beginning of the work of improvement occurred about a century ago. At that time, at least three different kinds of hogs were known in the Miami valley; and after this others were introduced from time to time for more than twenty-five years. The ones which are thought to have been most extensively used in developing the breed were the Russian hog, which was white in color and quite large; the Byfield hog, which was also white; the Big China hog, which played a large part in the development of the Poland China, particularly in the way of improving its form and quality and giving it early maturity; the Irish Grazier, another large, white animal; and the Berkshire, which gave to the new breed its black color.

The color of the Poland China is black with six white points. By the latter expression is meant that it has white on its face, on each of its feet, and on the tip of its tail. It is noted for its depth and width of body, for its well-filled hams, and for its ability to take on fat at an early age. Its face is straight and of medium length; it has lopped or drooping ears; and its back is curved or arched.

(b) THE BERKSHIRE. This is an English breed and one of the oldest. Its home is the counties of Berkshire and Wilts. At the time when we won our independence, the swine of that section were noted for their size, some of them weighing as much as one thousand, or even eleven hundred pounds. These hogs were sandy, or reddish brown, with some black spots; and they were covered with long coarse, curly hair. The great change from that type to the Berkshire of the present day is due largely to the importation of hogs from China, Siam and Italy; and by the blending of these hogs with the original stock as well



STANDARD BREEDS OF SWINE

YORKSHIRE

POLAND CHINA

BERKSHIRE

as by careful selection of the best animals for breeding purposes, the development of the Berkshire as we know it now has been brought about.

The color of the Berkshire is the same as that of the Poland China; that is, it is black with six white points. But here the resemblance may be said to end, for the Berkshire is longer in body but not so wide nor deep, it has longer legs, its back is practically straight rather than arched, its ears are not drooping but erect, and its face is short and not straight but dished, by which we mean that the snout turns up at the end. While the Berkshire is regarded as belonging to the lard type of hogs, its meat contains much more lean than does that of the Poland China and is preferred by many people for this reason. However, many farmers believe that it grows more slowly and will not fatten at so early an age as will the Poland China.

(c) THE DUROC JERSEY. This is another American breed. It is red in color; and the origin of this red color we are not able to trace. We know that slave traders brought some red hogs from western Africa in an early day; that Henry Clay imported red hogs from Spain in 1837; and that Daniel Webster likewise imported red hogs from Portugal about fifteen years later; but we do not know whether the breed of red hogs which became popular in New Jersey some time after this last importation, and which were called New Jersey Reds, descended from any of these hogs or from the old-fashioned Berkshires, which as we have seen were sandy or reddish brown in color.

At about the same time that the Jersey Reds were being developed, another similar strain of red hogs were being developed in Saratoga County, New York. These were known as *Durocs*; and they were finally crossed, or amalgamated with the Jersey Reds, the resulting breed being known as the *Duroc Jersey*.

The Duroc Jersey resembles the Poland China strongly, save in color, which is a uniform red. The face is straight, or slightly dished and the ears drooping. The body is wide and deep, the hams full and the back slightly arched. Like the Poland China, the Duroc Jersey makes rapid growth and possesses the ability to fatten at an early age.

(d) THE CHESTER WHITE. A hundred years ago, a breed of white swine was raised in Pennsylvania, whose origin no one could explain though many thought the original stock had been brought from England by the Quakers. Other hogs were brought in from the outside and crossed with these white ones, producing finally a breed known as the *Chester County Whites*. In 1865 some of these hogs were taken west to Ohio where they were crossed with two different strains of swine. One of these crosses resulted in the improved Chester White of today, while the other gave the strain known as the Ohio Improved Chester Whites, or the O. I. C. strain.

The Chester White hog is easily distinguished from those previously studied by its white color. It is similar to the Poland China in form, though the body is neither so wide nor so deep and the back is nearly straight rather than curved or arched. The face is straight and of medium length and the ears lopped.

(e) THE HAMPSHIRE. This breed seems to have made its beginning when hogs from Hampshire, England, were imported to America in an early day. We can trace some of these English hogs to Canada, some to Massachusetts, and finally some to Kentucky; and it is in Kentucky and some of the central states that the breed has really made its greatest improvement, developing finally into the type with which we are familiar.

The Hampshire is easily recognized by the white belt around the body just behind the shoulders. Its legs are longer than those of the Poland China and the body is neither so wide nor so deep. Its face is of medium length and straight while the ears are almost erect but droop slightly forward. By some it has been regarded as of the bacon rather than the lard type. However, it fattens so readily when mature that it is now placed without hesitation by swine breeders among the lard breeds of hogs.

18. The Bacon Type. The form of the bacon hog is strikingly different from that of the lard hog in at least one particular. While the lard hog is required to have great width but not great length, the bacon hog is required to have great length but not great width. Ask the class to account for this.

The bacon hog must be long in order that the "side of bacon" for which the animal is chiefly raised may be large, especially in length; but if the animal is wide, it indicates that the side of bacon is too thick and fat. On the other hand the lard hog must not be long, lest, owing to the great weight of fat, the animal become sway-backed; but it should be wide because this makes it possible for a large amount of fat to be deposited.

Aside from this general difference in form, the bacon hog has lighter hams and shoulders than the lard hog and the animal usually stands higher from the ground owing to its having longer legs.

While the number of bacon hogs raised in the United States is limited, it is probable that they will become more numerous here in the future. In view of this, at least the two important bacon breeds described should be studied.

(a) THE LARGE YORKSHIRE. This is regarded as perhaps the best of the bacon breeds. It is an English breed, taking its name from the English county of Yorkshire. The history of the breed is unique in that it was not developed by farmers nor general swine breeders but by factory laborers living in the outskirts of two or three manufacturing cities. More than fifty years ago, many of these men became interested in an annual swine-raising contest resulting from the offering of prizes by agricultural societies. A writer in 1871 in speaking of the fairs of that section said: "There is often a row of twenty or thirty fat pigs, all as white as soap and water can make them, stretched on beds of clean straw, contending for the first prize of four pounds, the second prize of three pounds, the third of two pounds, and the fourth of one pound." And the picture drawn by this writer shows us precisely how this highly important breed of bacon swine originated.

The large Yorkshire hog is long in body and long in legs. Moreover its depth from back to underline is great so that the side of bacon is both long and wide. The animal is white in color with dished face and erect ears. Its narrowness of body is noticeable especially to Americans who are accustomed to the wide lard type of swine. It attains a very large size if allowed to mature. However, when raised for bacon purposes, it is usually marketed when weighing from 175 to 220 pounds, as is the case with practically all other bacon hogs.

(b) THE TAMWORTH. This hog cannot be traced to its beginning. It is believed to be a direct descendant of the wild hog of ancient Britain. The breed has been recognized for a century or more; but as late as 1850 it was so imperfect in form as to hold a low place in popular favor. It was the only important bacon breed at the time when the laborers of Yorkshire were developing the new type of hog which has since taken first place among bacon breeds of swine — the Big Yorkshire; but at that time the Tamworth was extremely coarse, long in legs and shallow in body, being, like its progenitor, the wild boar, much better able to outrun its enemies than to make good bacon at anything like a reasonable age. Since then, however, by careful selection of the best animals for breeding purposes, it has been gradually improved until it has become an excellent bacon animal.

The Tamworth, when fully grown, is the largest of all hogs. One is on record that weighed more than sixteen hundred pounds. They are an exceedingly active breed, golden red in color, with a notably long head, a slightly dished face, and erect ears. They are noted for their fecundity, litters of pigs numbering fourteen or more being not unusual.

19. Why Hogs Are Extensively Raised. If we should make a survey of the farms of the United States, we should find that very many more farmers are raising hogs than are engaged in raising cattle, horses or sheep. There are two or three good reasons for this and the class should be asked to find out what they are, making inquiries outside of school if necessary.

(1) The rate of increase is much greater than that of the other animals named.

(2) The amount of gain per bushel of grain fed is greater than that of any other meat-producing animal. A bushel of nearly any grain when properly balanced with protein feeds will produce a third more pork than beef, or even more.

(3) Corn, which is the feed most used for live stock in the United States, runs high in carbohydrates and hence is especially adapted to the production of fat; and, since so large a part of the lard hog is fat, it is the animal that is able to use corn to the best advantage.

20. A Peculiarity of the Hog. By many people the hog is regarded as less cleanly in its habits than are other farm animals. This impression is largely due to its habit of wallowing in mud or water during hot weather. There is a very good reason why it does this. Allow the children to find out for themselves what it is if they are able to do so.

The hog cannot perspire as other animals do; and since the temperature of the bodies of animals can be regulated or controlled only by the evaporation of perspiration, which is a cooling process, the hog has no way to keep from becoming overheated in hot weather. This is the reason why it delights in wallowing in mud and water at such times. Unless shade or cool sheds are provided, wallowing places are necessary when the weather becomes very hot. It will not do, as many farmers have found to their sorrow, to throw cold water upon pigs when they are overheated, since the sudden cooling frequently results in the death of the animals.

21. Where the Two Types of Hogs are Raised. If the question is asked as to how many of the class have ever seen hogs of the bacon breeds, such as the Yorkshire or Tamworth, it will probably be found that very few have done so, notwithstanding all may be familiar with one or more of the lard breeds. It is true that the number of bacon hogs raised in the United States is very small while in some other countries, as Canada, England or Denmark, practically the only swine raised are of this type. The class should be able to account for this since the reason is obvious.

As has been stated, corn, which is the chief ration for swine in our country, is a natural fat-producing feed; and hence the lard type of hog is best adapted to our conditions. In many foreign countries, the grain and other rations fed are not so one-sided but produce more of lean meat and less of fat; and so the bacon type of hog is the one best adapted to the conditions which exist there.

22. Rations Given to Swine. The principal feeds given to growing and fattening hogs in the United States, together with the percentage of carbohydrates, of fats and oils, and of proteins in each one are given in the table.

KIND OF FEED	Carbohydrates	Fats and Oils	Proteins
Corn	66.8	4.3	7.8
Barley	65.3	1.6	8.4
Wheat Middlings	45.7	4.5	13.0
Kafir Corn	44.3	1.4	5.2
Oil Meal (Old Process)	32.0	6.9	30.2
Oil Meal (New Process)	35.7	2.4	31.5
Tankage	None	11.6	50.1
Skim Milk	5.3	0.3	2.9

FEEDS FOR HOGS. The nutritive ratio of the ration fed to hogs depends upon the age of the animals. Ask the children to explain just why this is true since it depends upon the principle, which has already come to our attention in the study of other farm animals, that young animals require more of the proteins in proportion to the amount of carbohydrates consumed than do older ones for the building of the tissues which make up their growing bodies.

It follows that the proportion of proteins required gradually decreases as the age of the animal increases, becoming least when it is fully grown. However, since the hog is an animal of rapid growth, the nutritive ratio changes rapidly, nor does it remain the same for any considerable length of time — all of which makes it a truly difficult matter to keep the ration properly balanced for a herd of growing pigs. As nearly as has been determined, the proper nutritive ratios for hogs of different ages and weights are as follows:

AGE	WEIGHT	NUTRITIVE RATIO
2 to 3 months	50 lb.	1 : 4.0
3 to 5 months	100 lb.	1 : 5.0
5 to 6 months	150 lb.	1 : 5.5
6 to 8 months	200 lb.	1 : 6.0
1 to 10 months	300 lb.	1 : 6.4

At this point the class should be required to calculate a number of different rations for hogs of specified ages, using different combinations of the feeds given in the list above. The method used in balancing these rations was explained fully in the study of rations for cattle.

Nothing can be more important here than to emphasize in every possible way the futility of trying to raise swine on a ration of corn alone, which is a common but costly practice throughout the leading grain-producing states of our country. To show this, ask the class to calculate the nutritive ratio of corn from the figures given above. It will be found to be about 1 : 9.8. Have them compare this with the nutritive ratio required by swine of different ages. It will at once appear that corn alone is not a proper diet for hogs of any age, though the nutritive ratio is more nearly correct for adult, fattening animals than for those that are young and growing.

23. Green Forage for Swine. Many farmers at all times keep their hogs in dry lots or in buildings and sheds especially provided for them. Others allow them to run in pasture just as they do their cattle and horses.

We do not ordinarily think of the hog as a grass-eating animal. In fact if the question is put to the class, there will probably be some who hold that it is not.

The truth is that hogs can live on green pasture just as do cattle and horses; but it is also true that they usually do somewhat better if some grain is fed in connection with the pasture. One of the very best ways to balance the corn ration, which has been shown above to be unsuitable for hogs, is to allow them to run in pasture, provided it is of the proper kind.

It is necessary that the pasture consist of plants containing a high proportion of proteins. Blue grass is excellent during the early months of the season, but not so at all after the arrival of hot weather. The reason for this should be found by the class in the fact that the heat of summer checks the growth of this pasture crop more or less completely, as was explained in our study of pasture and meadow grasses (pages 60, 61). The best of all pasture, or forage crops as they are called, for hogs is alfalfa. Next after this, rape has given best results, while red and sweet clover have also been found to be excellent.

The teacher should emphasize as strongly as possible the importance of forage crops for young swine. The difference in weight between the average pig seven or eight months of age that has been kept in a dry lot on a corn diet and the average pig of the same age that has been kept on a good pasture with a comparatively small amount of corn, is approximately one hundred pounds in favor of the latter animal; and since the cost of producing the two is nearly the same, it follows that the proper use of pasture or forage crops greatly increases the profits of swine raising.

24. Allowing Swine to Balance Their Own Rations. One of the most satisfactory methods of raising swine yet found is that of allowing them to balance their own rations. A large box, called a self-feeder, which is divided by partitions into three bins, is provided; and it is so arranged that the feed from each bin runs out into a trough at the bottom, but only as fast as it is eaten. Into one of these bins is usually put shelled or cracked corn; into another, wheat middlings; and into the third, tankage, or meat meal. Thus the pigs have perfectly free choice not only as to what they shall eat but when they shall eat as well.

The results of this method of feeding are not what many people would expect. The gains are not only more rapid, but they are more economical as a rule than can be secured even by the most experienced and skilful feeders. The pigs do not overeat; neither do they waste feed; and they require much less attention and care than when fed in the usual manner.

This is known as the free choice, or self-feeding method of feeding swine. Information as to how the self-feeders may be made may be secured by writing to the agricultural experiment station of nearly any one of the states.

SHEEP

25. Two Types of Sheep. Sheep are raised for two distinct purposes — mutton and wool; and the two types which result differ from each other in much the same respects as do beef and dairy cattle.

The mutton type, for example, is low-set, wide, and deep in body; and it has a notably heavy "leg of mutton." It produces some wool, of course, but this is secondary. The primary purpose for which it is raised is meat production; and the wool is usually inferior in both quality and quantity to that of the wool breeds.

The wool type of sheep is comparatively long and narrow in body and not so low-set A peculiar characteristic of this type is that the skin lies in folds, thus increasing the surface from which wool may grow.

26. Mutton Breeds of Sheep. Practically all the mutton breeds of sheep originated in England. The principal ones are:

(a) The Southdown. This is the smallest of the mutton breeds but one of the most perfect in form. It has no horns. Its forehead and cheeks are covered with wool, while its face and legs below the knees are covered with short, light brown or gray hair. The fleece is rather short, but compact. The weight of the Southdown varies from 125 to 175 pounds.

(b) The Shropshire. This breed is larger than the Southdown and not so blocky in form. It, too, is hornless. Its forehead, cheeks and face nearly to its nostrils are covered with wool. Its nostrils and feet are dark brown in color. While it is somewhat inferior to the Southdown in mutton form, its fleece is much heavier.

(c) The Hampshire. This sheep is recognized by its dark brown or nearly black face, by its drooping ears, its rather coarse, rangy form, and the tendency to Roman noses, especially in the rams. It was originated by crossing the Southdown upon native horned breeds, which were narrow and rangy in form. The horns disappeared; but the rangy form of the native sheep is still seen to some extent. It is larger than the Shropshire, weighing from 180 to 250 pounds when mature. Its fleece, however, is hardly any heavier than that of the Southdown and much lighter than that of the Shropshire.

(d) The Oxford Down. In this we have one of the largest of all breeds of sheep. Its weight ranges from 200 to 325 pounds, or nearly double that of the Southdown. Like the Southdown, its forehead and cheeks are covered with wool, while its face and legs are medium brown in color. It lacks the blocky form of the Southdown, though its longer wool gives it the appearance of having great width and depth.

(e) The Dorset Horn. This is the first horned breed to be studied. It is easily recognized by the fact that both rams and ewes have horns, and also pure white legs and faces. The Dorset Horn has not been developed by the crossing of other breeds but by selection of original native stock, which accounts for most of its peculiarities. In size it is about equal to the Shropshire but its fleece is lighter. It is noted in particular for its prolificacy.

(f) THE CHEVIOT. Like the Dorset Horn, this sheep has white feet and legs, but it has no horns. The breed was developed in the Cheviot Hills, which form the boundary between Scotland and England. Its size is practically equal to that of the Shropshire and Dorset Horn, the average weight of fleece being about the same as that of the latter. It is an exceedingly hardy, active animal.

(g) THE LEICESTER. The six breeds which we have studied above are all known as short wool sheep since the average fiber of the fleece is in most cases only from three to five inches in length. There is, however, another general class, including several mutton breeds, which are known as long wool sheep. The Leicester is one of these. Its wool is from six to ten inches in length, but much less dense than than that of the short wool breeds. It usually lies over the body in loose, spiral locks, or curls. This sheep has no wool on its forehead, cheeks, face or lower legs, these being covered with soft, white hair instead. Its weight ranges from 180 to 240 pounds.

(h) THE COTSWOLD. This is another of the long wool breeds. Its wool is longer than that of the Leicester, ranging from eight to fourteen inches in length. It is moreover a somewhat larger animal. It is recognized by the curls or locks which hang down from its forehead over its face.

(i) THE LINCOLN. The Lincoln is the largest of all sheep. Its weight varying between 275 and 350 pounds. Moreover, its fleece is longer and heavier than that of any other mutton breed, the length of the wool being from ten to eighteen inches. It is similar to the Leicester in appearance save for the difference in size.

27. Wool, or Fine-Wool Breeds. These sheep are of the wool type rather than the mutton type. All are descended from the native Merino sheep of Spain though the leading wool breeds have not originated there but from Merino sheep taken to other countries.

There is a general classification of wool sheep based upon a very peculiar difference; that is, the number of folds in the skin. These classes are designated as follows:

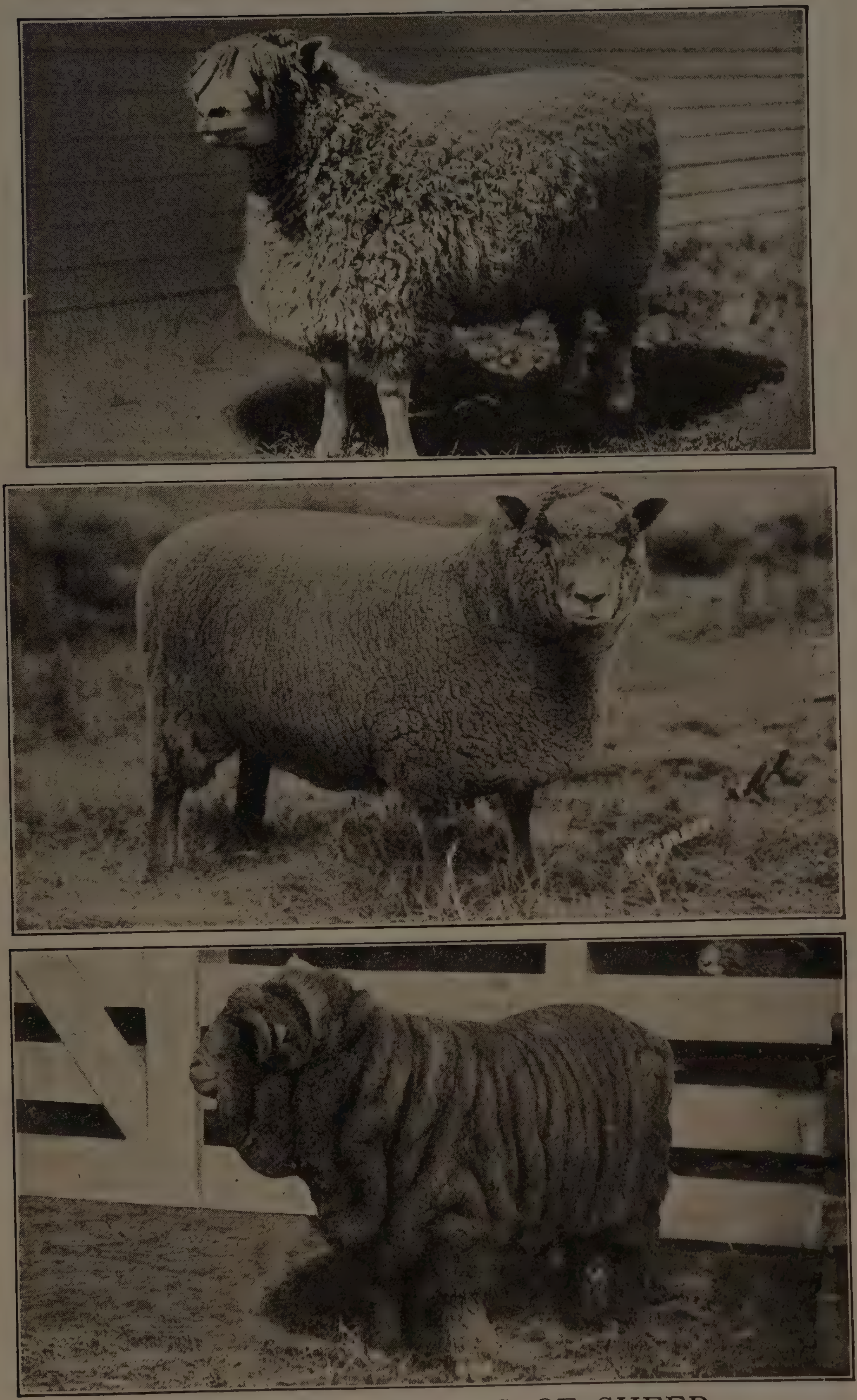
(a) CLASS A, MERINO. This class includes those animals having many heavy folds over the neck, body and hindquarters, and having an abundance of grease, or, as it is called, *yolk*, in the wool.

(b) CLASS B, MERINO. Class B includes animals having fewer folds on neck and body and having less yolk in the wool.

(c) CLASS C, MERINO. This class includes animals having few folds or none and a relatively small amount of yolk in the wool.

(d) THE AMERICAN MERINO. This breed of sheep was developed in the United States from stock brought from Spain. It bears the finest wool of any breed in existence. The fleece covers the entire body save the nose, lower third of the head, and the ears, which are white. The amount of yolk is so great that the shrinkage in washing may be as high as sixty-five per cent. The ewes are hornless while the rams have heavy, spirally twisted horns. In size, the American Merino is smaller than any of the mutton breeds, the average weight being from 100 to 150 pounds.

(e) THE DELAINE MERINO. This breed was also developed in the United States from Spanish Merino stock. There are several families, or strains, belonging to it; and these vary considerably in size and conformation. They resemble the American Merino in a general way. Their fleece, which is known as Delaine wool, can be combed and spun in full length fibers, making an unusually strong, durable fabric, which is used in making fine, untwilled, worsted dress goods.



STANDARD BREEDS OF SHEEP

Cotswold

Southdown

Rambouillet

POULTRY

NOTE: There are several species of domestic fowls that are referred to collectively as poultry. Only chickens, however, are of any great importance; and the study of the others will not be taken up in this article.

29. Three Types of Chickens. Of each kind of domestic animal so far studied, we have found two distinct types, whose general characteristics were determined by the peculiar purpose for which the animal was raised. Chickens are not of two types, but three, due not to their being raised for three different purposes, but to the fact that an intermediate type has been produced which combines quite satisfactorily the desirable characteristics of the other two.

(a) THE EGG TYPE. Chickens of this type are comparatively small, neat and trim in appearance, and notably active. The body is spare, rather than heavily fleshed, though it is long and deep. These birds have as a rule large combs and wattles, and their shanks are without feathers. They are nervous in disposition, easily frightened, and fly as easily as do many species of wild birds. For best results they must be carefully handled, as excitement interferes with egg production. Because of their large combs and wattles and bare legs, chickens of this type are unable to endure extreme cold weather. Their nervous temperament makes against brooding qualities. In fact they are often spoken of as "non-sitters."

The most important breeds of the egg type are the Leghorns, whose native home is Italy, the Minorcas, which originated in the Minorca Islands, the Andalusians, and the Spanish.

(b) THE MEAT TYPE. The meat type of chicken is, as we should expect, much larger and heavier than fowls of the egg type. It has short legs, a short neck, and a deep, full body. It is sluggish, rather than active, and not at all excitable as compared with chickens of the egg type. It is slow in maturing since it attains greater size than others.

Hens of the meat breeds are comparatively poor layers, but have not, like those of the egg breeds, lost the brooding instinct. Rather, they are persistent sitters and excellent mothers though rather clumsy and awkward. Because of their sluggish movements, they are poor foragers. They do not have large combs and wattles; and their shanks are feathered, often to the toes. It follows that they can endure extreme cold far better than can the egg breeds.

The chief breeds of the meat type are the Brahmas, the Cochins, and the Langshans, all of which are natives of Asia. The Brahmas are the largest of all breeds of chickens, the males weighing up to twelve pounds while the females average about nine.

(c) THE GENERAL PURPOSE TYPE. Fowls of this type rank in size between the egg breeds and the meat breeds. However, their bodies are comparatively blocky and compact. They are not of an excitable disposition, though not so phlegmatic as the meat breeds. They grow rapidly, mature early, and are notably hardy. They do not produce as many eggs as do the egg breeds, though the difference is not large as a rule and the best individuals closely rival in this respect the best ones of the egg breeds. They have the brooding habit; but it is somewhat less strongly developed than in the meat breeds. In spite of this, they are regarded as excellent brooders, owing to the fact that they are more careful and less clumsy and so break fewer eggs than do the larger fowls. They are excellent foragers and able to withstand much colder weather than can the fowls of the egg type.

The most important of the general purpose breeds originated in the United States. Among these are the Plymouth Rocks, the Wyandottes, the Javas, the Dominiques and the Rhode Island Reds. Other important breeds of this type are the Orpingtons and the Dorkings, whose native home is England, and the Houdans, which are natives of France.

30. The Feeding of Chickens. The general principles which govern the feeding of other animals apply also to poultry. It is just as necessary that the rations of fowls contain sufficient proteins, for example, as that the rations of dairy cows should do so.

The nutritive ratio varies, of course, with the age of the fowl. The young chick requires a ration whose nutritive ratio is about 1 : 4. That of the laying hen should have a nutritive ratio of about 1 : 4.8; and the nutritive ratio for a fattening fowl should be 1 : 7.5.

It is necessary to keep in mind a few peculiar requirements of chickens as regards their feed. They must have grit of some kind, owing to the fact that it plays an important part in grinding, or crushing, the food in the gizzard. Moreover, this grit should contain the lime and mineral matter necessary for egg production. Oyster or mussel shells, or ordinary mortar, are convenient forms of grit for poultry.

Green feed is necessary if the best results are to be realized with laying hens.

The majority of successful breeders agree that meat in some form is nearly indispensable for large egg production. To supply this requirement, meat scrap, a packing house product, is usually fed.

TEST QUESTIONS

1. Think out clearly the points of difference between the beef type and the dairy type of cattle. Then write them in parallel columns.

2. In what localities are beef cattle most extensively raised? Why?

3. What breed of dairy cattle is most common in your locality? Do you know why other breeds are not raised there?

4. How can you tell a mutton type sheep from one of the wool type?

5. What breeds of horses are most common in your locality? Can you distinguish a Clydesdale from a Percheron when you see them together?

CHAPTER FIVE

ENEMIES OF THE FARMER

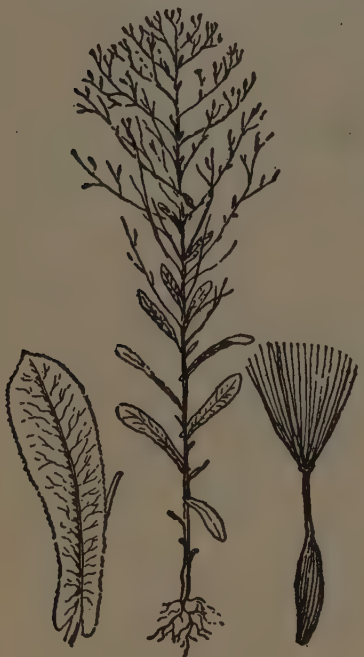
WEEDS

1. What Weeds Are. The term *weed* is used somewhat loosely, but it generally means a plant which is unsightly or injurious to other plants among which it grows. Our present application of the term is restricted to those plants that serve no useful purpose and that propagate themselves with great rapidity. Weeds shade the crops, deprive useful plants of their nourishment and rob them of a large amount of their moisture. The loss to crops in the United States by weeds amounts to several million dollars each year.

2. Classes of Weeds. It is a good plan to make a study of the life history of the weeds most troublesome in the locality. This study will disclose the fact that some weeds live only one year (annuals), some two years (biennials), and others more than two years (perennials). Each class needs special treatment.

The weeds which are so troublesome as to receive special notice by the United States Department of Agriculture are the Russian thistle, prickly lettuce, bracted plantain, horse nettle, buffalo bur, spiny amaranth, dagger cocklebur, chondrilla, wild carrot, wild oat, false flax and Canada thistle. Most of these are quite generally distributed over the country, but there may be others of local interest.

3. Points to Be Observed. Most weeds, and especially annuals, produce a large number of seeds, ranging from two thousand to eight thousand to the plant. The seeds are usually of strong vitality, and the plant has some means by which they may be widely scattered. The agencies through which these seeds are dispersed are the plant itself, the wind, birds and other animals. The seed vessels of some of these plants burst with considerable force, scattering the seed in all directions, but many annuals have stems with numerous



PRICKLY LETTUCE

branches, and when uprooted in the fall they are so nearly round that the wind blows them about readily and they scatter seeds wherever they go. Weeds taking this form are generally known as tumbleweeds, and the name is applied to several different species. Ask the pupils to find what plants produce seeds with burs or hooks so they can attach themselves to animals. Doubtless they are all familiar with tickseed and burdock, but they may never have thought of the purpose served by the seeds in sticking on to whatever comes in contact with them. Ask the class to find tumbleweeds, also to notice how the seeds of the thistle, milkweed and the prickly lettuce are scattered.

Why do weeds grow so profusely along fences and by the sides of roads? The answer to this question will lead pupils to see that birds perching on the fences frequently drop seeds which take root and grow.

Another way in which weeds are scattered is by their seeds being mixed with the seed planted for the crop. In this way the Russian thistle and others of the most injurious weeds in the country were introduced from Europe. The seeds of some of these weeds resemble the true seed so closely, as in case of clover and grass, that one must be an expert to determine whether or not such seed is adulterated. If in doubt, a small quantity of the seed should be spread upon a white surface and examined with a magnifying glass. This will bring out the difference in form and color, and whenever seed is suspected of adulteration, a very careful test should be made before planting.

Have the pupils gather the seeds of these different weeds as they mature and study them until they are able to recognize them wherever met.

The root of the weed should also be studied. Is it fibrous or fleshy? Can you tell from the root whether the plant will live one year, or longer?

4. Destruction of Weeds. The habits of the plant being known, the pupils should have their attention called to the most effective methods of their extermination and prevention. Since annuals die down to the ground at the end of the season, they can be exterminated by preventing them from seeding. Cultivation early in the season is, therefore, much more effective than at any other time. It must be remembered, however, that not all of the seeds of an annual germinate the first year. Some may remain in the ground for two or even three years, and however carefully the plot infested with such weeds may be tilled the first season, the farmer may expect a crop of the same weeds the second season, although it will not be so large, and possibly a few others will be found the third season; but by persistent cultivation from year to year, the weeds will be destroyed.

The first year biennials store their nourishment in the root, which enables the plant to develop very rapidly and produce a large number of seeds the second year. These plants can be killed by cutting off the root a few inches below the surface of the ground. This same method also applies to many perennials, though these weeds are more difficult to kill than those of either of the other classes. A spud, which is a chisel attached to a fork handle, is the most effective implement for this purpose. Where a plot is badly infested with perennial weeds like the Canada thistle, it is a good plan to plow the land, then rake together as many of the roots as possible, and when they are dry, burn them. This will not eradicate all of the weeds, but it will destroy a large number; and by following the plan at each plowing, in the course of two or three seasons the most of these weeds will be destroyed.

A SPUD USED FOR CUTTING WEEDS

The sources from which most weeds spring are untilled land, such as old pastures and the narrow strips along fences and roadsides in which the weeds mature and scatter their seed. However carefully one farmer may till his land and eradicate weeds from such places, he can never wholly free his land unless his neighbors are equally particular, for the seeds from most of these pernicious plants travel long distances. This point should be fully impressed upon the class in connection with this study. United action is essential to ridding any locality of noxious plants, destructive insects and plant diseases.

CANADA THISTLE

Some weeds are more troublesome than others, either because the roots spread rapidly or because of their large number of seeds. Such weeds as quack grass are propagated by cultivation of the land. Since plowing and harrowing breaks up the underground stems and scatters the sections over the field, each section takes root and propagates a new plant. Whenever fields infested with this grass are plowed, the *roots*, as the farmer generally calls them, should be gathered with a fine-toothed rake, dried and burned.

Such weeds as the ox-eye daisy and Canada thistle may be killed by pasturing the field, provided the pasture has enough stock to keep any grass or weeds from going to seed. The old roots gradually die, and several seasons of pasturing will usually destroy the weeds.

Some weeds seem to thrive better under some conditions than under others, hence rotation of crops is a means of destroying them. A crop of corn followed by another tillable crop, for instance, and then wheat or some other small grain, will free the land of weeds, if it is thoroughly tilled.

(a) USEFUL WEEDS. However troublesome weeds may be some of them are useful. Among these are the docks and the dandelion, whose roots possess valuable medicinal qualities. The roots should be dug in the fall just after the tops have died. Boneset, wormwood, foxglove, mullein, lobelia, tansy and many other weeds, when gathered and dried, form the herbs of commerce. The medicinal qualities of these plants are in the leaves and stalks.

Some weeds, like pokeweed, poison hemlock and poison ivy, are extremely poisonous and should be handled with care. Some people cannot even approach poison ivy without being affected by it. It can be easily recognized by its three leaves.

Send for Farmers' Bulletin No. 28, United States Department of Agriculture, *Weeds and How to Kill Them;* also Farmers' Bulletin No. 188, *Weeds Used in Medicine.*

DISEASES OF PLANTS

5. Injurious Effects. Nearly all plants raised upon the farm are subject to disease. The diseases are caused by minute plants (fungi or bacteria) which live upon or within the plants that they injure or destroy. These plants are so small that single specimens cannot be seen without a magnifying glass, and some of them only by the aid of a compound microscope. The damage done to cereal crops alone in the United States by plant diseases is estimated at $200,000,000 annually. In addition to this, nearly half of the apple crop is lost each year by rot, and in some localities the entire peach and plum crop is destroyed in a similar manner. Much of this loss could be prevented if the farmers knew what to do.

For this reason, the subject of plant diseases is one of the most important of those introduced in agricultural courses. The boys and girls who study this topic in their school days will not be at a loss to know what to do when, as farmers and farmers' wives, they must grapple with the problem of keeping the farm products free from disease. Instruction in this subject is eminently practical, and if made a part of the school work generally over the country, will result in untold good in future years. The teacher should therefore be thoroughly prepared to teach the subject so as to obtain the best possible results. This applies also to the study and teaching of insect pests, treated farther on in this chapter. Knowledge of how to conserve the health of farm plants is of priceless value to the farmer.

6. What to Teach. The prevention and destruction of fungi causing plant diseases depend upon a knowledge of the manner of growth, length of life and changes in form of the fungus causing the respective diseases with which the plants are affected. The lessons on plant diseases should acquaint the pupils with these facts. As far as possible the facts should be learned by direct observation; but those which can be ascertained only through the work of specialists should be given the pupils as they are needed.

The diseases which should receive attention first are those that are causing the greatest damage in your locality. The time at which the lessons are given should depend upon local conditions. The effect of the disease is best seen at that season of the year when the crops reach maturity, but its progress can be studied to the best advantage during the weeks preceding this, and the means of prevention should be considered in the spring before the planting begins. A few diseases, like fire blight and black rot, can be studied in the winter. The lessons should be given when they will be most effective. You should become acquainted with the subject which you wish to teach, both by observation and study. In addition to the information which you can gain from original sources, you should add all that can be acquired from reading the works of good authorities. Be enthusiastic; awaken an interest in the pupils and lead them to become enthusiasts in this work, and their influence will have a very beneficial effect upon the community in which your school is located.

7. Preliminary. The pupils are probably familiar with mushrooms and puffballs. Have each pupil bring to the class a ripe specimen of mushroom and puffball, if these can be obtained. The large mushrooms with gills are the best for this exercise. After picking, they should be kept with the top down.

Have each pupil lay a piece of paper on the desk. If the mushroom is white, use colored paper; if dark, use white paper. Break the stem from the mushroom close to the gills, then lay the top on the paper, gills down; cover with a glass and leave in this position for a half-hour or more. When you return to the exercise, ask the pupils to remove the glass and the mushroom from the paper very carefully, raising each directly up and taking care not to create the least current of air. What does each pupil find upon his paper? (If the experiment has been successful an imprint of the under side of the mushroom will have been formed on the paper by the spores which have fallen from between the gills.)

Ask one of the pupils who has a ripe puffball to squeeze it. What forms the cloud of dust? Catch some of the dust on white paper. Can you see the separate grains? What about their size?

From these exercises the pupils should gain some knowledge of the large number of spores produced by plants of this sort, of the minute size of these spores and the ease with which they can be scattered. This will lead them to see why plant diseases can spread so rapidly.

While it is not necessary to describe the minute structure of a spore, you should lead the pupils to understand that in plants of this class it takes the place of the seeds in the more perfect plants they have been accustomed to study.

Caution. Some mushrooms are deadly poisons, and pupils should be told emphatically that they must not eat them.

When these facts are understood, the class can study the plant diseases which are considered most important. The topics outlined for study in this division of the lesson are selected because these diseases are generally prevalent, but there are many not named, and some of these may be of equal or greater importance in your immediate locality; hence, you should be guided in your choice of topics by local conditions.

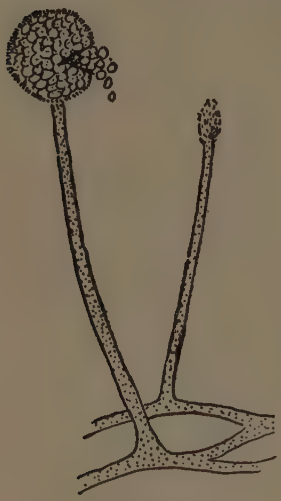
8. Rusts. Rusts appear on wheat and other small grains and grasses. They are so called because of the peculiar color of the spores which they produce. The disease is caused by a minute fungus. It usually begins with little black dots and lines that appear on the surface of the stem late in the summer. These lines are made of innumerable spores which constitute the form in which the fungus survives the winter. In spring each spore begins to grow. However, it dies in a short time unless it is carried to a barberry bush. Upon the leaves of this shrub the spores continue to grow rapidly and soon form little chains of fringed cups on the lower side of the leaves. These cups produce a different variety of spore, which is carried by the wind or other means to wheat, grass or other crops where these spores force their way into the pores of the leaves and mature the fungus that spoils the crop. The fungus has three distinct stages in its life circle, and a complete knowledge of it requires observation extending from one season over to the next. The spores in the spring usually start from self-sown grain; therefore, all such grain should be plowed under early. They also adhere to the straw and are liable to be carried to the field the next season and infest a second crop, if such straw is used for fodder or bedding. Fields affected with smut should have the stubble burned after harvest, and it is usually wise to burn the straw. The margin of the field should be kept free from barberry bushes and other plants on which these spores may lodge. These measures and a frequent change of crops will usually prevent the spread of rust.

Have the pupils examine neighboring fields for the appearance of rust. If it is found, ask them to measure a square foot of the field in some part where the disease appears, count the number of plants within the space measured and also the number affected with rust. From these a very fair estimate of the portion of the field affected can be obtained.

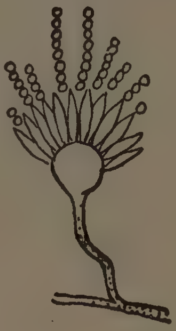
9. Smut. Smut attacks wheat, oats, barley, and especially Indian corn. It is developed and propagated by the means of spores, in much the same manner as rusts. However, the spore of the smut fungus works differently from that of the rust fungus. Some spores are capable of attacking the plant only when it is young. The spore penetrates to the interior and grows toward the end of the stalk, dividing wherever the stalk divides and sending a minute filament into each branch until finally it works to the tips of the shoots which bear the fruit. For this reason the presence of smut cannot be detected until the fungus is fully developed. This is best illustrated in corn. With this plant the smut does not appear to cause any damage until the kernels are well formed. Then in the course of a few days those at the end of the ear swell, burst and throw out a large quantity of black powder which consists of the perfected spores. These can be carried long distances by the wind. They lodge in the soil, fall upon manure heaps or find homes in other suitable places, where they develop a second kind of spore which is carried to the corn plant the next season and begins its career on the new crop.

Because of the large number of spores and the way in which the fungus works, smut is very difficult to eradicate. Whenever possible, the ears affected by it should be destroyed and seed from an affected field should not be planted. When smut attacks oats or barley, it may not be discovered until thrashing time; then the escaping spores form clouds of black dust. Spores can be destroyed on the seed by soaking the seed from ten to fifteen minutes in water raised to a temperature of 132 to 135 degrees Fahrenheit. The heat should not exceed the latter temperature and the seed should be thoroughly stirred so that the water may be brought in contact with the entire surface of every kernel. This treatment does not injure the vitality of the seed and it often saves the farmer a crop. When a field is badly affected with smut it should be planted to some crop upon which this fungus cannot work. One or two seasons of this treatment will eradicate the disease.

10. Potato Blight. There are two forms of potato blight, known as the early and the late blight. The pupils should be asked to look for the appearance of this disease, and if found it should be studied. The early blight is due to the growth in the tissues of the leaves of a fungus which causes the leaves to turn yellow and dry up. This blight does not usually affect the tubers. However, if it begins early in the season, it decreases the yield. The later blight is likely to attack the crop during warm, damp weather. It sends its filaments down the stalk into the tubers and causes them to rot. Farmers not understanding the nature of this disease think that the rot is due to some condition of the soil. Both of these diseases can be prevented by spraying the vines with Bordeaux mixture (see Section 25). Usually three applications in a season will preserve the plants in good condition. Sometimes the spores from this blight do not develop until the tubers have been stored for the winter, and the farmer is much surprised to find that his potatoes are rapidly decaying.


WHITE MOLD

11. Scab. Another disease which is likely to affect potatoes is scab. Doubtless pupils can bring potatoes that have been attacked in this way. Examine the scabs with the magnifying glass. Each scab is a plant and grows from a spore. The spores may exist in the soil before the potatoes are planted. This will be true if the ground produced a scabby crop of potatoes the previous season. If affected potatoes are planted, an affected crop may be expected; therefore, only healthy potatoes should be used for seed. The scab can be prevented by dipping the potatoes, before planting, in a solution made by adding a pint of formalin (a liquid that can be obtained of any druggist) to fifteen gallons of water, and allowing them to remain in the solution from one and one-half to two hours. Formalin is not poisonous, but potatoes thus treated should not be eaten nor fed to stock. Study the apple scab in the same manner. Doubtless in the fall numerous apples having black scabs on the surface can be obtained. These are caused by another sort of fungus which works upon the apple in a similar manner.

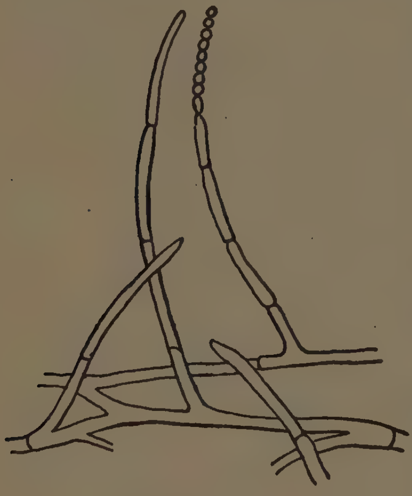


BLACK MOLD

12. **Molds or Mildews.** Place a piece of bread in a damp, warm place where it is excluded from the light and allow it to remain for several days. Have the pupils, with a magnifying glass, examine the mold formed. With a glass of good power some very interesting forms will be discovered. There are many species of mold or mildew, and they attack numerous plants, especially the rose, grape, plum and peach, and often cause serious damage. The most common forms are shown in the illustrations printed on pages 132, 133 and 134. They are highly magnified. Mildew on grapes can easily be detected by examining the under side of the leaves, where it appears in the form of pale spots or scales, which are covered with silky, thread-like organs. The mold on fruit usually appears as a whitish bloom or roughish brown coating. The latter is known as brown rot, and it is very destructive to plums and peaches. The fruit so affected

BLUE MOLD

often remains on the tree and dries, forming what are known as *mummies.* These dried fruits are full of spores, and unless they are destroyed will constitute a source from which the disease will be propagated to the next crop. The brown rot and most other mildews can be prevented by spraying either with a simple solution of copper sulphate in a proportion of one pound of sulphate to eighteen or twenty-five gallons of water, or by a weak solution of Bordeaux mixture. Two or three sprayings during the season will be necessary to preserve the fruit, and the result depends almost entirely upon the thoroughness with which the work is done. Every branch and leaf of the tree should be touched by the spray.



MILK MOLD

If fruit is grown in the locality in which your school is located, lead the pupils to watch for the appearance of these molds and then secure their interest in spraying trees.

13. Other Diseases. The plans given show what can be done with other plant diseases. If you live in one of the cotton states, you will need to give attention to the numerous diseases which attack the cotton plant. If in a tobacco region, other diseases are important. Send to the experiment station of your state for information on diseases prevalent in that locality, and you will secure much valuable assistance. Send to the Department of Agriculture, Washington, D. C., for Farmers' Bulletin No. 75, on *Grain Smuts and How to Prevent Them*, also for Bulletin No. 20 of the Bureau of Vegetable Physiology and Pathology. Each of these works will furnish valuable information.

DESTRUCTIVE INSECTS

14. Classes. For the purpose of destroying them, insect pests are considered under two classes, biting insects and sucking insects. This distinction is important, because insecticides that are effective with the first class are harmless to the second. Biting insects feed upon foliage, and any preparation which poisons the leaves of the plant destroys the pest. Sucking insects feed upon the juices of plants and extract them by boring through the outer tissue or bark; therefore, poisoning the foliage has no effect upon them. A preparation which poisons the insect by contact must be employed. Spraying mixtures containing Paris green or London purple will usually destroy biting insects, and a preparation of kerosene known as kerosene emulsion, or a solution of tobacco soap, will destroy most sucking insects. Where plants can be enclosed, lice can usually be destroyed by fumigating the plants with tobacco or with carbon disulphide. In all cases spraying or fumigating is most effective if applied early, as soon as the insects are discovered. (See Section 25 for spraying preparations.)

15. Directions. Lead the pupils to understand the facts here given and to apply them in connection with the study of insect pests. For the life study of these insects, follow the plans given in Volume IV, in Chapter on Insects. In studying insect pests, it is necessary for the pupils to learn:

(1) To recognize the insect in each stage of its growth—the egg, the larva, the pupa and the imago.

(2) How long the insect lives in each stage.

(3) Upon what the larvae feed.

(4) The time and place of laying the eggs.

(5) How the insects pass the winter.

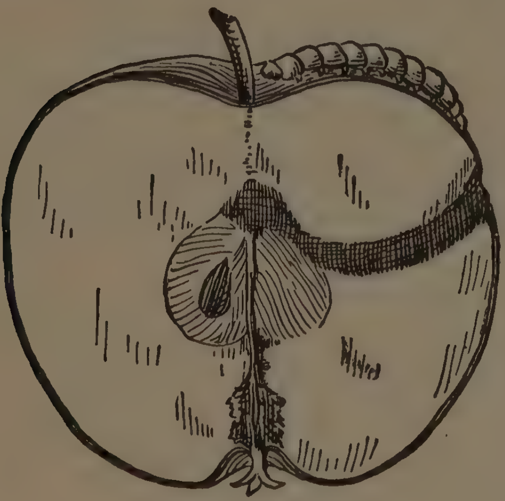
(6) How the ravages can be prevented.

To ascertain these facts it will usually be necessary for the class to continue observations through a year.

16. Cabbage Worm. What sort of butterfly is seen around the cabbages about the time the young plants begin to head? Have the pupils catch some of these in the insect net and place them in their cages. Place fresh cabbage leaves in the cage each day. Do the butterflies lay eggs on the leaves? Put some worms in the cage and feed them till they change to the chrysalis stage. From what is the chrysalis suspended? How long does it take it to hatch? (In the North there are usually three broods in a season; in the South the number of broods is greater.)

The cocoons of this butterfly are often found in the fall, suspended from the under side of fence boards, railings and other similar shelters. By placing boards on the ground in a cabbage patch in such position that the worms can crawl under them, many cocoons will be fastened to the boards and these can be collected and destroyed. This is one of the most effective means of keeping this pest in check. Since poisons cannot be used after the plants begin to head, they have but little effect.

17. Codling Moth. How many of the class ever found a worm in an apple? How did it get there? What is it there for? Lead the pupils to examine the apples on a tree early in the season, very soon after the blossoms fall. Are any milk-white spots found on the growing fruit? If so, examine some of them with your strongest magnifying glass. Can you tell what they are?


CODLING MOTH

Have each pupil select a few affected apples on a tree at his home and watch these spots from day to day. What change finally takes place in these spots? What becomes of the worm? When does the worm leave the apple? Where does it spin its cocoon? Later in the season, in early autumn or in midsummer, pupils should look for these cocoons under the scales of the bark on the trunk of the tree. Doubtless a number will be found upon each tree. If these scales, which form the rough bark, are scraped off, many cocoons are destroyed and one of the favorite places for spinning the cocoons is removed. This can be done without injury to the tree. Have the pupils collect a few cocoons and keep them in a safe place until they hatch in the spring. In this way they will be able to recognize the moth, which is seldom seen. Do not let the moths escape.

It is estimated that the damage done by the codling moth in the states of Nebraska, Illinois and New York exceeds $7,000,000 each season; therefore, any preventive measures which will stay its ravages should be understood and employed. The following are among the most effective:

(1) Since decaying fruit trees form the best places for hatching the cocoons, all such trees, as well as all brush in and about the orchard, should be destroyed.

(2) The trees should be sprayed with Bordeaux mixture just as the blossoms fall, and again in about a week or ten days.

(3) Trunks of trees should be kept smooth, so that the worms cannot find lodgment for the cocoons.

(4) Many cocoons can be collected by banding the trees with strawboard, cotton flannel or any other fabric that will form a shelter to the worms.

(5) Wormy apples usually fall to the ground before the perfect fruit is ripe. These should be gathered as soon as they fall and so disposed of as to kill the worms before they emerge to spin cocoons. They may be used for making cider or feeding pigs.

18. The San Jose Scale. The San Jose scale is a minute insect covered with a circular scale of ashy gray color and about one-sixteenth of an inch in diameter. The young are brought forth alive; the insects multiply at an almost incredible rate and in a short time cover the bark, leaves and fruit of the infested plant. The scale is a sucking insect; a plant infested with it has no chance for growth, and little for life. A tree covered with this scale has the appearance of being dusted over with ashes. The young crawl about for a short time after birth, but the insects cannot fly, hence they are unable to travel from one plant to another unless the branches interlace. They sometimes, however, attach themselves to other insects and are carried in this way.

This scale is one of the most destructive insects with which the fruit grower has to contend. It thrives equally well on a number of plants, including the peach, plum, pear, quince, apple, apricot, gooseberry, hawthorn, rose, spirea, maple, English walnut, elm and persimmon. The most effective treatment for San Jose and most other scales is to spray the dormant trees in late winter with the lime-sulphur wash. This is made by adding five pounds of quicklime to about two gallons of water in an iron kettle. Boil and stir in slowly four pounds of powdered sulphur. Boil for an hour. Dilute to twelve gallons with water. This must be applied while the buds are still completely dormant.

All fruit trees should be examined every spring for scales. If any are found, the trees should be sprayed at once with a mixture of lime, sulphur and salt. The natural enemies of the scale are a small fly which is a parasite, and some species of beetle known as ladybugs or ladybirds. It is also supposed that the scales are affected with a fungous disease, but this is not definitely known.

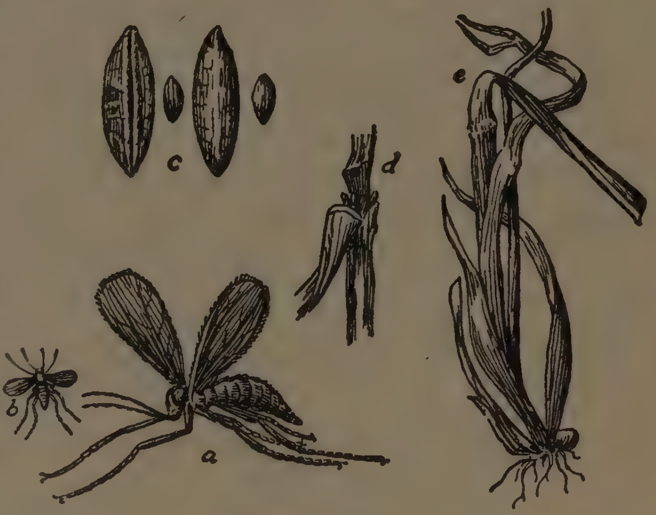
Send to the Department of Agriculture, Washington, D. C., for Circular No. 42, second series, entitled *How to Control the San Jose Scale.*

19. Other Insects. With insects as with plant diseases, those that are most destructive in your locality should receive first attention. In addition to those already named in this division, the following should doubtless receive attention: The Colorado or potato beetle, the squash bug, the striped cucumber beetle, the currant worm, the rose slug, the tent caterpillar, apple-tree and peach-tree borers, the plum curculio, plant lice, in grape and cotton regions the insects which attack these plants, respectively, and in wheat regions the Hessian fly, the chinch bug and the weevil.

INSECT ENEMIES

20. Aid to the Farmer. The farmer is not left to fight noxious insects single-handed. Nature has provided numerous enemies which lend their assistance to the destruction of these pests. Chief among these enemies are other insects, birds, those animals which feed upon insects, and certain fungous diseases whose ravages often destroy large numbers.

21. Parasitic Insects. Insect parasites consist of smaller insects which lay their eggs in the larvae of the larger. The egg hatches and the larvae of the parasite live and grow by feeding upon the tissues of the larvae upon which the eggs are deposited. In this way the larva of the host is destroyed. The most numerous family of parasites consists of the ichneumon flies. These vary in size from half the size of a mosquito to minute flies that can scarcely be seen with the naked eye. They are of great value in destroying those insects which are injurious to growing crops. The chalcis flies are also valuable in destroying the codling moth, and the tachina flies destroy the Hessian fly, one of the worst enemies of growing wheat.

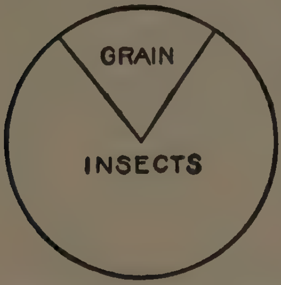


HESSIAN FLY

a, Fly, magnified; *b*, natural size; *c*, pupa cases ("flaxseeds") in different stages, natural size and magnified; *d*, barley stem, showing "flaxseeds" in position; *e*, stem bent down as a result of the work of the Hessian fly.

22. Birds. Birds are among the farmer's best friends, but often they are looked upon as enemies. In The Study of Birds in Volume IV is given a plan for the study of birds. You should now have the pupils turn this suggestion to practical account by studying the economic relations of birds to man. A careful study of this plan on a few of our most common birds will show that with rare exceptions birds are beneficial in destroying insect pests.

The nestlings of some birds, particularly of the robin, the crow and the sparrow, which in the adult stage feed to some extent upon fruit and grain, are wholly insectivorous; therefore, while at certain periods these birds may commit slight depredations upon crops, the insects which they destroy during the season would cause much greater damage.

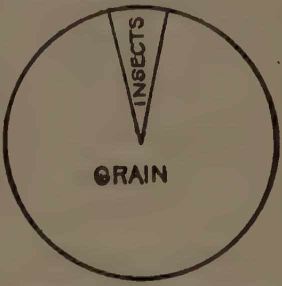


RED-WINGED BLACKBIRD

Have the class make a study of the food of a few birds that can be observed about the home. The illustrations show the relative proportions of insects, grain or fruit that constitute the food of the adults of a few common birds. These are fairly representative of many others. They illustrate more forcibly than words the folly of killing the birds or attempting to do away with them.

(a) THE ROBIN. Let each pupil select a robin's nest that is in a good place for observation. Watch the nest for an hour at a time at different periods of the day, as morning, midday and evening. How many times are the young birds fed each hour? Make a note of what is given them at each feeding, as, earthworm, caterpillar, bug. Make the first series of observations soon after the birds hatch, the second in about a week, and the third in two weeks. Compare results. At the rate observed, how many insects would this family of robins consume during a season?

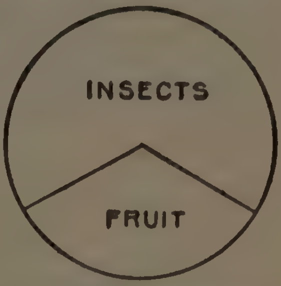
(b) THE SPARROW. The chipping sparrow is one of the most common birds about lawns and yards. Its habit of building its nest in low bushes by the side of walks makes it one of the most convenient birds to study. The chipping sparrow is easily tamed and will often come on to the porch, the threshold or the window sill to pick up crumbs. Use the same plan for study as with the robin.



ENGLISH SPARROW

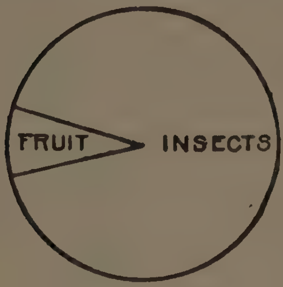
What does the chipping sparrow feed its young? Of what does the food of the adult consist? (About two-thirds of the food is vegetable, one-half of which is doubtless seeds of wild plants and the other half grain.) The young eat cutworms, weevils, crickets, grasshoppers, bugs and spiders.

(c) THE WOODPECKER. Woodpeckers are more difficult of observation. The points to be determined in their study are the extent to which they damage trees and the extent to which they prevent injury to the same trees. Some species are more injurious than others, because they drill larger holes into the tree. What is the woodpecker after when it drills through the bark? How can you find out? Why does the woodpecker strike the tree in various places before drilling?



BROWN THRASHER

By experimenting on an old tree that is of little value, the pupils can partially satisfy themselves on these points. Direct them to cut away carefully the bark around a hole drilled by the woodpecker, then by cutting the wood away carefully follow this hole to the end. Does the hole drilled meet an excavation made by a borer? Experiment with several holes. Do all of these lead to holes of borers? If not, why are the others made?



BLUEBIRD

The greatest injury which woodpeckers cause trees is in the loss of sap in the spring, which leaks out through the holes that they have drilled in the bark. The large woodpeckers which drill large, deep holes are consequently more injurious than the smaller species.

(d) THE CROW. Do crows remain in your locality throughout the year? If not, when do they migrate in autumn? At what date do they return in the spring? Why do farmers generally wish to kill crows? Is the crow the farmer's friend? How can you determine? How can cornfields be protected from crows?

At least one-fourth of the crow's diet is animal, and it eats bugs, grasshoppers, cutworms, tent caterpillars and noxious animals, such as mice and snakes. While the crow destroys some corn and fruit, in most localities it probably more than repays for this damage by the large number of noxious insects which it destroys.

Study other common birds in a similar manner. In order to satisfy yourself about the food of any bird you will have to make many observations, and probably will not arrive at a full knowledge of what the bird eats without studying it for two or three seasons. To assist in this study make a chart according to the plan here given. This plan can be extended whenever it is necessary to add another insect to the list. It is a good plan to have the oldest pupils construct charts of this kind and observe birds through the summer, then bring these charts to the school sometime in the fall term and compare notes. A star in the chart indicates that the bird eats the animal or vegetable matter named at the top of the column:

	Grain	Weed Seed	Fruit	Caterpillars	Bugs	Beetles	Grasshoppers	Ants	Spiders	Earthworms	Cutworms	Cankerworms	Small Animals	Miscellaneous
Robin			*	*		*	*		*	*				
Sparrow	*					*	*							
Woodpecker			*			*		*	*					*
Crow	*		*	*			*						*	*

23. Other Animals. The most important of the insect-eating animals of this group is the toad. Have the pupils study the life history of this little animal. In so doing they will learn how it feeds, what it eats, and many other interesting facts. Toads should be protected and attracted to the garden. This can be done by providing moist, shady places under leaves and stones for their shelter during the day and by constructing a few little pools of water containing water lilies and other aquatic plants.

Frogs and salamanders may also be considered as insect enemies, but they are of little practical assistance to the farmer.

24. Diseases. As already noted, the San Jose scale is supposed to be affected with a fungous disease which tends to place some check upon its multiplication. A disease affecting the chinch bug has been known practically to destroy this pest over large areas in a single season. At one time it was thought that the chinch bug could be exterminated by inoculating bugs with the disease and liberating them in infested fields, but the results were not so satisfactory as anticipated. Find what diseases destroy other insects.

25. Insecticides. The following insecticides can be prepared and applied by anyone:

(a) PARIS GREEN, DRY. Paris green, 1 pound; lime or flour, 20 to 50 pounds. Mix thoroughly.

(b) PARIS GREEN, WET. Paris green, ¼ pound; lime, ¼ to ½ pound; water, 50 gallons.

Caution. Paris green is poisonous, and all receptacles containing it should be marked *Poison*, and should be kept out of the reach of children.

(c) KEROSENE EMULSION. Hard soap in fine shavings, ½ pound; soft water, 1 gallon; kerosene, 2 gallons. Dissolve the soap in boiling water, add kerosene to the hot water and churn with a spraying pump until the mixture is changed to a cream and then to a soft, butter-like mass. To get a 15 per cent emulsion, the one most commonly used, add 10½ gallons of water to the mixture.

(d) COPPER SULPHATE. Copper sulphate, 1 pound; water, 18 to 25 gallons. This mixture is useful in killing spores before foliage comes in the spring.

(e) BORDEAUX MIXTURE. Copper sulphate, 5 pounds; unslaked lime, 5 pounds; water, 50 gallons. The copper sulphate and lime should be prepared separately and then poured together. By adding 4 ounces of Paris green to 50 gallons of Bordeaux mixture, the mixture is suitable for both insects and fungi. Thus, by spraying potatoes with this combination both blight and potato bugs are destroyed.

(f) AMMONIACAL COPPER CARBONATE. Copper carbonate, 5 ounces; strong ammonia, 3 pints; water, 50 gallons. The copper carbonate should be dissolved in the smallest possible amount of ammonia and the solution kept in stock and diluted when needed.

26. Aids. *Nature Study and Life*, C. F. Hodge, Ginn & Co., contains valuable information and suggestions for the study of insects and diseases of plants.

Agriculture for Beginners. Burkett, Stevens and Hill. 339 pages. Ginn & Company. This is a very useful book for both teacher and pupils. The style is plain and simple, the work is remarkably free from technical terms, the subjects treated are such as everyone interested in agriculture should understand, and the illustrations are both beautiful and useful. The work also contains valuable tables and recipes.

Principles of Agriculture. Bailey. 288 pages. Macmillan Company. This work gives a clear and systematic discussion of the elementary principles of agriculture. It covers about the same ground as *Agriculture for Beginners*, but is designed for more advanced students.

How to Make School Gardens Hemenway. 107 pages. Doubleday, Page & Company. This little work gives many valuable hints and suggestions about making the school garden and the lessons which can be taught from it. It is beautifully illustrated with drawings and halftones.

Among Country Schools. Kern. Ginn & Co. Boston, Chicago. A valuable book for the rural teacher.

You should write to the agricultural experiment station of your state for such literature and assistance as it can furnish in the work. You will find that your request will meet with a liberal response.

Bulletins and circulars from the United States Department of Agriculture: Besides those already mentioned in the chapter, the following will be found helpful:

Circular No. 84, *The Grasshopper Problem and Alfalfa Culture.*

The Food of Nestling Birds, by Sylvester D Judd. Reprint from a yearbook of the Department of Agriculture for 1900.

Farmers' Bulletin No. 132. *The Principal Insect Enemies of Growing Wheat.*

Farmers' Bulletin No. 146. *Insecticides and Fungicides.*

Farmers' Bulletin No. 196. *Usefulness of the American Toad.*

Farmers' Bulletin No. 243. *Fungicides and Their Use in Preventing Diseases of Fruits.*

FARM PROJECTS

The farm, including the garden and orchard, offers an almost unlimited number of practical projects such as children and young people of school age can carry out.

On the farm itself is found the main problem of raising grains, as corn and wheat, hay and clover, and other large crops. Then the breeding and care of stock, as sheep, swine, chickens, cattle and horses offers a limitless number of projects in animal husbandry.

The equipment of the farm with sheds, barns, silos, chicken houses, windmills, corn cribs, granaries and milk houses, offers a still broader range of special undertakings. The handling and repair of farm machinery opens up another interesting series of practical projects.

Problems of fencing, of road-making, of drainage, of preserving soil fertility, of crop rotation, of selecting, buying and caring for seed, of water supply, of wells and troughs may be added.

The combination of field crops with stock raising, with dairying, pasturage and care of wood lots or timber tracts, and these combined with construction of farm buildings, sanitary arrangements about houses and stables, the extensive use of machinery and its upkeep and repair, and lastly the marketing of the great variety of farm products, gives a remarkable range and complexity of projects in which children are naturally interested.

The variety of improvements about the farm house, the water supply, the heating and lighting, the cooking arrangements, the garden and orchard, furnish a large number of additional improvement projects.

The scope of feasible projects on an ordinary farm is so manifold that it is difficult to see how one family can handle all of them successfully.

It is not strange that the farm has been regarded as a good training ground for the developing boy, for the simple reason that it offers so many projects that stimulate initiative and resourcefulness. Such varied adjustments to farm needs are a constant demand for intelligence, for forethought and flexibility of mind, for persistence in carrying forward long-developing schemes to final success.

A few of these farm and garden projects are outlined in the following series as suitable for the changing seasons, and the varied conditions on different farms:

Projects connected with the dairy:

Plan for the development of a dairy herd.

Selecting the better breeds of dairy cows, as, Jerseys, Holsteins, etc.

Keeping the milk record of individual cows, so as to eliminate unprofitable animals from the herd.

Plan and arrangements of a dairy barn to secure ventilation, cleanliness, proper feeding and milking.

The plan and construction of a silo in connection with the dairy barn; filling the silo.

The milking program, the sterilizing rooms.

Care of the fresh milk as to cooling, icing and sending to market.

Planning the farm crops with reference to silage and feeding the dairy cows through the seasons.

Farm projects:

Working out a crop rotation suitable to a given piece of land or field—first season clover, second season corn, third season oats, and so in succession.

The selection and testing of corn for seed.

Determination of a standard ear.

Culling out the best ears in the field.

Testing the germinating quality of ears thus selected for planting.

Preservation of seed corn during the winter months.

A plan for selecting the seed and planting an acre of sweet corn, such as Golden Bantam, for sale in the summer market.

Project for preparing and planting an alfalfa field:

Soil inoculation.

Plowing and careful preparation of field.

Drainage requirements.

When to cut the alfalfa and how to handle it in the field and barn.

Soil Improvement as a project:

An examination of soils to find out what kinds of fertilizers are needed on a given farm.

Tests for acid soil; how to deal with sour land.

Value and use of stable manures; use of lime and rock fertilizers.

The planting of legumes as fertilizers.

The expense of fertilizing and estimating the improved values obtained.

Comparison of these different methods of fertilizing lands and the benefits from keeping up the soil fertility.

A drainage project:

Plan for draining a pond or swamp.

A survey to determine levels and slopes as a basis for drainage.

Laying out the main line for the ditch.

Size and quality of tile required; lateral drains.

Provision for a permanent outlet.

Building a catch-basin as a means of control of tile drainage.

Testing the effects of tile drainage in seasons of flood.

Soil and productivity of tiled swamp land.

Estimate of costs and benefits of tile drainage.

Chicken raising projects:

Selection of a special variety, as Plymouth Rock or Black Minorcas, for developing superior breeds or blooded strains.

Study of favorite breeds for egg-laying and meat production.

Building a chicken house, with suitable arrangements for feeding and nesting.

Devices and cures for dealing with insect pests.

The feeding of chickens and a well-balanced ration.

Selection and use of an incubator.

A season's plan for hatching, raising, feeding and marketing chickens.

A study of market for the best disposal of eggs and poultry.

Sheep-raising projects:

What kind of a farm is best suited to sheep-raising?

Plan for developing a flock of sheep running through several seasons.

Kind of sheep best for wool and meat.

Kind of pasture best suited for grazing.

How to house the sheep in winter.

Building of sheep sheds to protect from rain and storms.

Proper feeding of sheep during winter.

Care of lambs in springtime.

Shearing time and care and marketing of fleeces.

Study of the market for sale of wool and mutton.

Project of buying a flock of lambs in the spring and feeding them for the fall market.

Effects of sheep-raising on soil fertility and use of grains and farm products for feed.

Special garden projects:

The general plan for a vegetable garden.

Deep plowing or spading and fertilizing of soils.

Plots for early vegetables, as lettuce, radishes, beets and cabbage.

Plan for construction of a hot bed for raising plants, as tomatoes, cabbage, celery and lettuce.

Project for an asparagus bed:

Deep spading and abundant use of fertilizers, need of good drainage, plenty of humus.

The planting in ditches of well-developed roots, with complete use of fertilizers.

Careful weeding and cultivation of the bed.

Cutting asparagus tips in springtime.

Planting a strawberry bed:

Preparing the soil by spading.

Selection of plants suitable for family use or for the general market.

Putting in the plants and cultivation.

Uses of mulch in covering the plants.

Cultivation and care of runners.

Picking and use of the berries.

A grape arbor:

Selection of a sunny spot for an arbor.

Construction of the frame for the vines.

Selection of suitable varieties of vines.

Planting in well-fertilized ground.

Training and pruning of the vines.

Protection from insect pests and mildew by spraying.

Preparation by means of cuttings, by layering and by grafting.

TYPE STUDIES IN AGRICULTURE

CHARLES A. MCMURRY, PH.D.

COTTON

Suggestions as to Method

(a) The development of the cotton-producing and manufacturing industries has been dependent upon the invention of a whole series of machines. Note carefully how man's remarkable ingenuity has overcome the difficulties and has thus laid the basis for one of the greatest industries in the world.

(b) The simple, primitive modes of treating cotton, as separating from the seed, spinning and weaving, need to be clearly explained and illustrated and shown in pictures in order to waken appreciation of the spinning jenny, the cotton gin, the power loom and the cotton picker.

(c) The organization of industry (capital, labor, cities, division of labor and large management) in our modern factory system is well illustrated by the cotton industry.

(d) The thinking powers of children are well put to the test by explaining the reasons for selecting the centers of manufacture for cotton goods and the chief lines of shipment.

(e) The industries dependent upon by-products are a fine illustration of economy in industries based upon modern science and its uses.

(f) The location of the cotton belt in the United States and the comparison with other cotton-producing regions give a good map study and consideration of climatic conditions.

(g) The other great textiles brought into comparison with cotton enlarge this topic to a great world problem.

Outline of Topics

1. Primitive spinning and weaving. Cottage industry.
2. The cotton gin, the cotton picker and cotton press.
3. The spinning mule.
4. The power loom.
5. The organization and management of the factory.
6. Suitable centers for manufacturing.
7. Improvements in transportation. Steam engines.

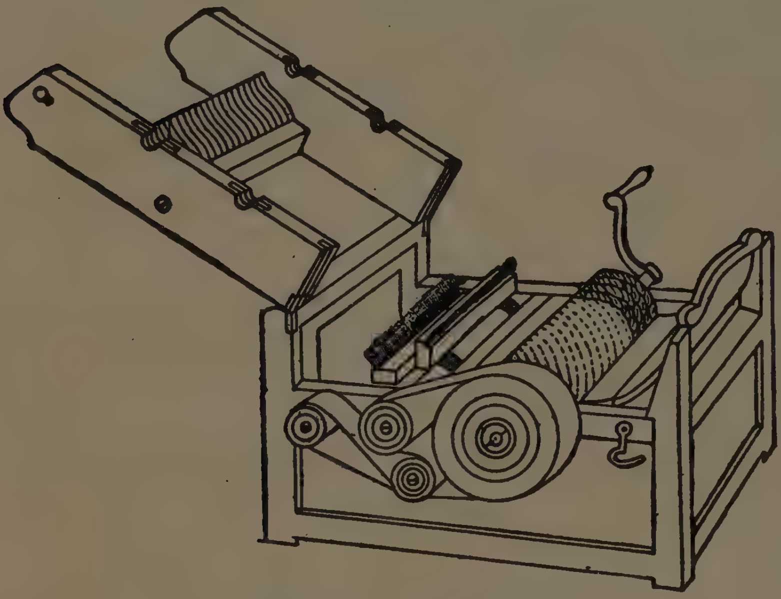
8. The by-products of the cotton plant.
9. Flax-production in Europe.
10. Hemp in the Philippines and in Kentucky.
11. Wool-production. Wool-growing countries.
12. Silk: China, Japan, Europe, America.
13. Knitting and lace-making.

COTTON

1. No other plant appropriated by man for his special needs has been of more value to him than the cotton plant, and it is because it enters so fully into the everyday life of the human race that it deserves special study. The furnishings of our beds, the towels with which we dry our hands and faces, and a large proportion of our clothing are made wholly or partly of cotton fabrics, and the fibers of this plant are used in a variety of other ways too numerous to mention. The United States produces more raw cotton than any other land, but the plant thrives in various places in the world between the thirty-fifth parallels on both sides of the equator. It is an important product of India and Egypt, and can be cultivated elsewhere in Africa, and in South America and Australia. The history of this valuable plant dates back to a time beyond the memory of man, and it is described by writers who lived many years before the birth of Christ. The manufacture of cotton products as now conducted is, however, a matter of modern history, for it is only within the past century or so that the industry has had the advantages of labor-saving machinery. The story of its development is told in the following pages.

The raising and harvesting of cotton and the processes of changing cotton fibers into cloth involve a long series of remarkable inventions. It is worth while to find out how men, by their inventive skill, have overcome the natural difficulties which stood in the way of the development of this great series of cotton-raising and cotton-manufacturing industries. Some of these inventions are of American origin, others originated in Europe.

More than a hundred years ago, before the modern improvements in spinning and weaving, the work of making cloth from cotton and other fibers was done by hand. The crude hand loom for weaving had been in use for hundreds and thousands of years in many different lands. The spinning wheel was also in common use, and both these primitive machines are still employed in many countries. Up to the time of the American Revolution the old spinning wheel and hand loom were employed and the work was done in thousands of cottages. There were no great factories or mills and there was little division of labor. Making cloth was a house industry carried on by the people scattered in villages in parts of England, Scotland and other countries.



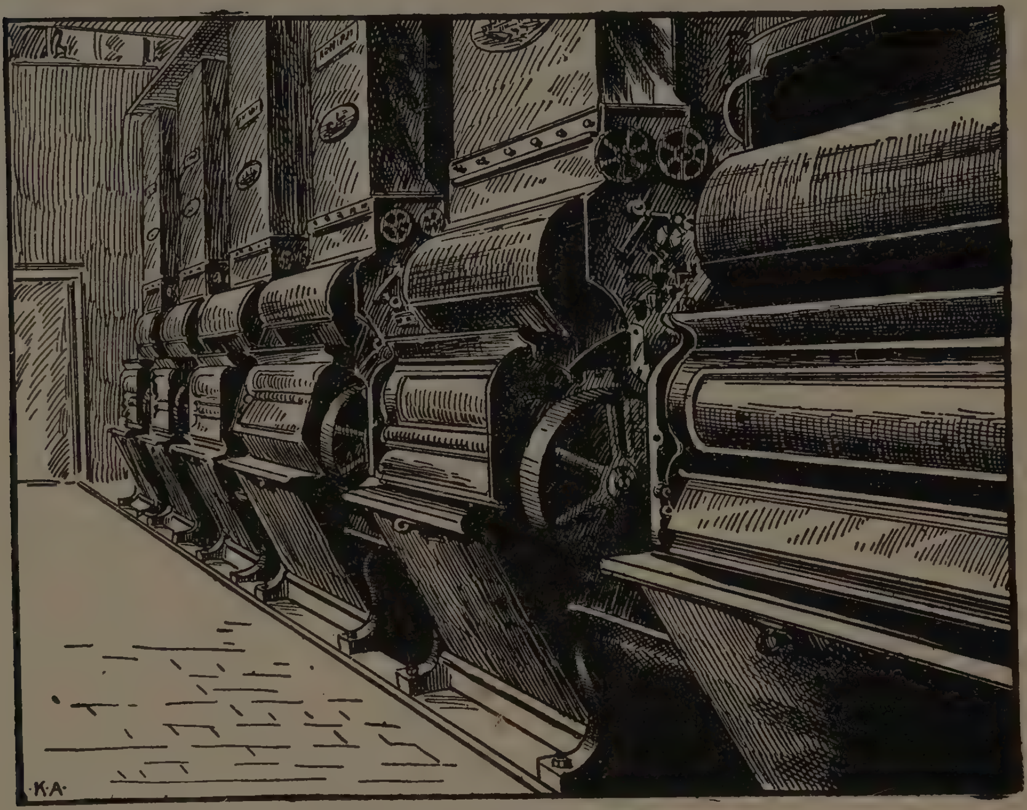
THE FIRST COTTON GIN
After a drawing of the original model

2. In the cotton industry as a whole there were two great problems that had to be worked out before the business could develop the great importance it has at the present time.

First was the difficulty of producing a large quantity of cotton on the plantation, of freeing it from the tightly wrapped seeds and of getting it in baled form for shipment.

In the United States cotton-raising and manufacture did not come into importance till after the Revolution. The planters had begun to cultivate cotton in the southern states, but the work of separating the cotton fibers from the seed was exceedingly tedious and costly. It was done by hand,

and laborers for this and the field work were all too scarce. A Yankee boy, Eli Whitney, going into South Carolina to teach school, was encouraged by the wife of General Greene to devise a machine for more quickly separating the cotton fibers from the seeds. With few tools and much ingenuity he contrived such a machine. By means of circular saws working through wires he pulled the fibers loose from the seeds and carried the seeds away, collecting the lint. The machine was a complete success. One man working by hand all day could separate from one to four pounds of cotton fibers from the seed, while one of Whitney's cotton gins would produce hundreds of pounds of clean fibers in a day. This invention changed the whole face of things in the southland. With plenty of laborers in the field they could produce any amount of cotton, which could be sold very profitably



THE MODERN COTTON GIN

Compare with Whitney's original invention, illustrated on opposite page to the mills of England and other countries in Europe and later to the rapidly developing factories of New England.

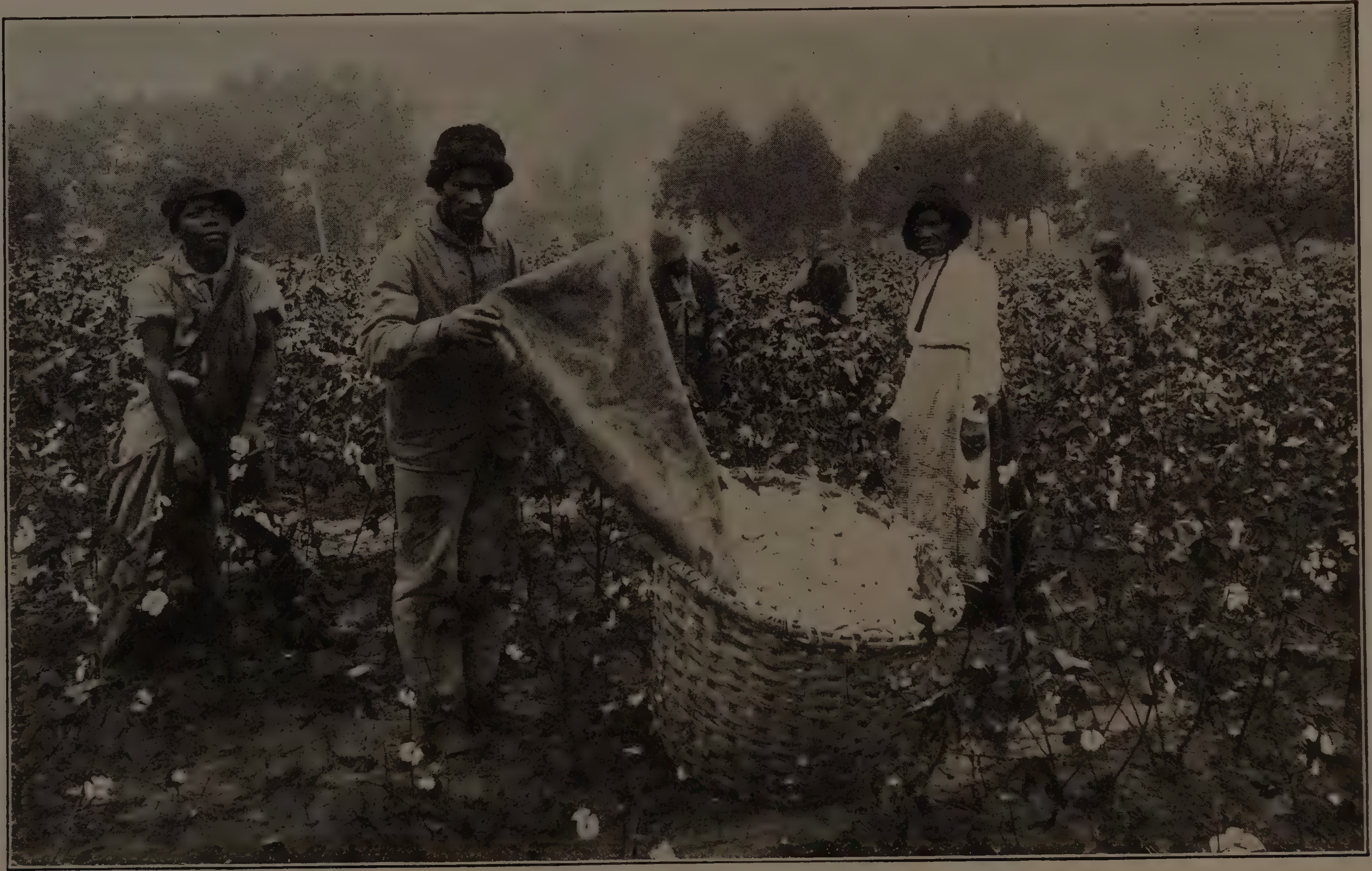
The invention of the cotton gin, by making easy the separation of cotton fibers from the seed, produced a rapid extension of cotton-planting in the south. As negroes were very useful in the cultivation of the cotton crop, there was a much increased demand also for slaves. The invention of the cotton gin therefore is given as the chief reason at this time for the rapid extension of slavery throughout the south.

The cotton gin, although a complete success at first, has been much improved in later times. Every plantation at first had a small cotton gin, but in later years the cotton has been collected from many plantations at central stations, where large improved cotton gins and great cotton presses can handle any amount of cotton at a small expense.

For more than a hundred years no very marked improvement was made in the harvesting of cotton. Picking cotton has always been tedious and has employed a large number of hands. During the cotton-picking season the fields of the south have employed men, women and children by thousands and tens of thousands. A quicker and cheaper method by machinery was much needed. In recent years various attempts have been made to devise a machine that would take the place of hand labor in picking cotton. A successful cotton-picker has now been invented and put into use, so this important labor is being gradually taken out of the hands of the negro, and he must learn to make a living in some other way.

After the cotton has been ginned, another machine compresses it into bales, which are tightly bound with iron strips. It is now ready to be shipped by rail or by ocean steamer to New England or to distant lands to supply the machinery of great mills with the raw material for weaving many kinds of cotton fabrics.

3 In the manufacture of cotton goods there has been developed a series of most ingenious machines for carding, spinning, weaving and dying the cloths. Some of the most



PICKING COTTON

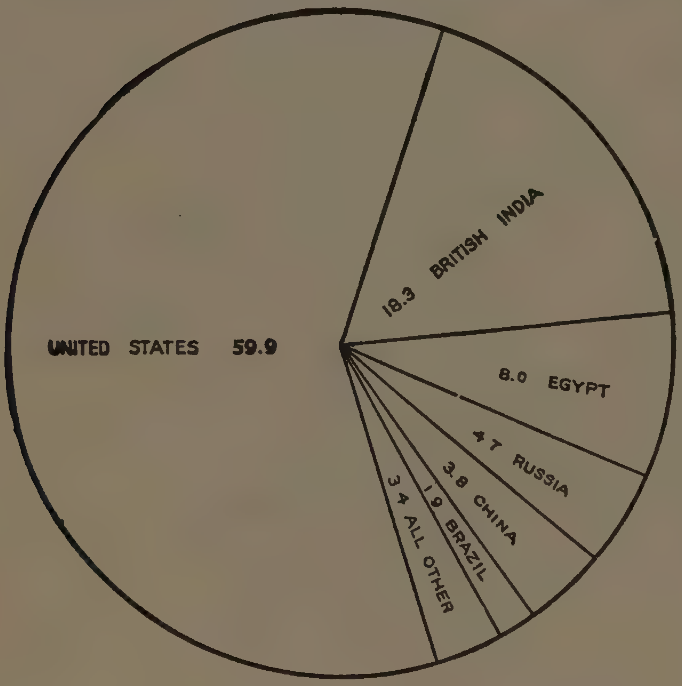
remarkable inventions devised by men have been worked out by skilled machinists who were struggling with the difficulties of working over the cotton fibers. Chief among these inventions are the spinning mule and the power loom.

The process of spinning was once performed with the old-fashioned spinning wheel, by which the delicate fibers of cotton are drawn out and twisted into thread. Instead of one thread slowly drawn out and twisted by hand, now, by means of the spinning mule, hundreds of threads are drawn and twisted by a single workman. The spinning mule is a combination of ingenious devices gradually brought to perfection by hundreds of inventive minds engaged in cotton-manufacturing.

COTTON FLOWER AND BOLL

Preceding the spinning is a series of remarkable machines, the cleaners, the carders and drawing frames, by means of which the tangled fibers are cleaned, combed and straightened and then shaped into uniform strands ready for the weaving. The fleecy strands or slivers, as they are called, are taken up by the spinning machines, drawn out and twisted into threads, which are rolled upon spools ready for the looms. The cleaning, carding, drawing and spinning machinery makes a whole series of complicated processes whose sole purpose is to produce the threads or yarn out of which cloth is woven. Great factory buildings are devoted to this thread-making process.

4. In order to weave cloth rapidly and in large quantities it was necessary to improve upon the old hand loom, the shuttle of which was thrown by hand and the harness for shifting the threads was moved by a foot-treadle. In 1783–85 the power loom was invented and brought into use in England. This loom can be run either by water or by steam power, but its general introduction was dependent upon the invention of the steam engine. In the power loom the shuttles move back and forth in the weaving process with lightning speed, and the woven product is far greater. In a single mill sometimes several thousands of these looms are at work, and the number of yards of cloth turned out is enormous. The looms have been improved by new inventions and devices till now the self-acting automatic loom has reached a high perfection in weaving. It can even pick up broken threads and does not require skilled workmen to manage it successfully.



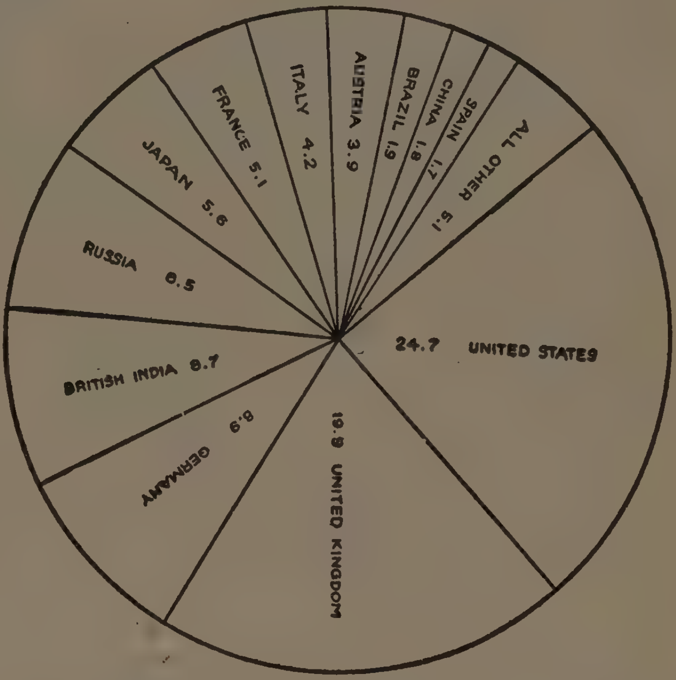
PROPORTION OF WORLD'S SUPPLY OF COTTON CONTRIBUTED BY EACH COUNTRY

In our modern factories the importance of a mill is expressed in the number of its spindles and looms. For example we say that in the southern states in 1902 there were 6,250,000 spindles and 130,000 looms in use.

5. The various machines used in the process of spinning and weaving made it necessary to combine all these processes

in great manufacturing plants. If the raw cotton is to be converted into finished cloth in one factory, the machines and processes of cleaning, carding, spinning, weaving and dying must be combined in one related series. As soon as one machine and set of workmen complete their part, the next machine and group must take it and carry it one step further, and so on through one continuous series of processes and machines till the finished cloth appears.

It requires a high degree of ingenuity and administrative ability to organize one of these large mills and cause all the parts to work together steadily in the production of cloth.



PROPORTION OF TOTAL CONSUMPTION OF THE WORLD'S COTTON SUPPLY—FROM CENSUS REPORT, 1911

This kind of manufacturing could no longer be carried on in cottages and by hand as formerly. Instead of this, expensive buildings and machinery must be brought together, and hundreds of thousands of workmen or operatives are required to direct the machines and processes. The result has been that the cotton-manufacture is now carried on in cities where large numbers of operatives can be depended upon, and millions of capital are invested in engines, machines and buildings. This has involved also the management of hundreds and thousands of skilled and unskilled workmen, including men, women and children in a single plant.

6. In developing the cotton industry also it has been necessary to select those regions of the world best adapted to the cultivation and later to the manufacture of cotton cloth. In the southern and gulf states south of 35° north latitude have been found the soil and climatic conditions (temperature and moisture) favorable for cotton cultivation. In consequence about three-fifths of all the cotton produced in the world is raised in this part of our country. As high as 14,259,290 bales, each of 500 pounds, have been raised in one year. It has been estimated that the United States when developed to its full capacity can produce 50,000,000 bales in a year without encroaching upon other crops.

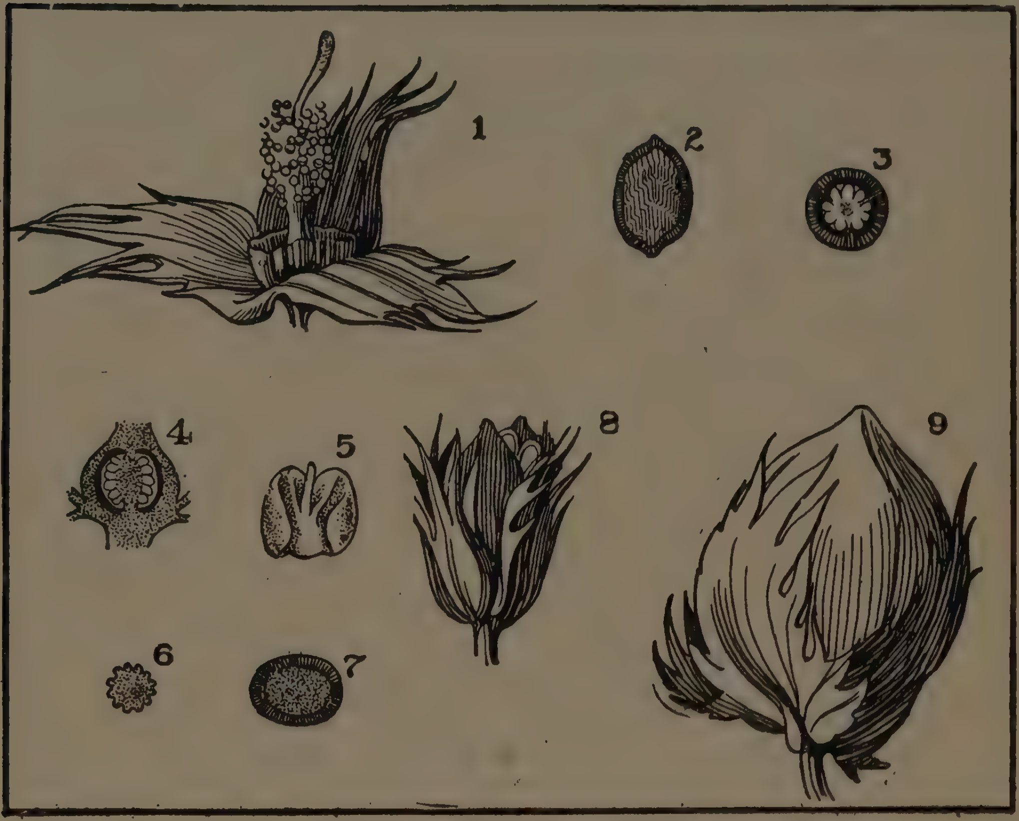
It was equally important to find localities favorable by climatic conditions of moisture and temperature for spinning and weaving. The region about Manchester, England, was found to be peculiarly favorable to cotton-manufacture because of its moist atmosphere and nearness to the ocean. Equally necessary were the capital and mechanical ingenuity in building up the large manufacturing plants.

In New England, also, at Fall River, Lowell and other cities not far from the coast, were found not only the climatic conditions favorable, but also extensive water power serviceable for the machinery of the mills. For many years, till about 1880, New England was the important center for cotton-manufacture in the United States.

Later it became evident that cotton factories established in the southern states would bring about a large economy by saving the expense of thousands of miles of shipment to New England or to Europe. Along the outskirts of the southern Appalachians abundant water power is also supplied by the rivers of that section.

During the last thirty years men have profited by these peculiar advantages of the South and have steadily increased the factories in the region till now nearly as much cotton is spun and woven in the South as in the North. In the Carolinas, Georgia and Louisiana factory towns have grown up and the cheaper grades of cotton goods are made, not only for the South, but for China and other foreign lands. Of the total crop of American cotton about one-third is now manufactured in the United States and two-thirds in Europe, mostly in England, Germany, Belgium, Holland and France.

7. In the development of the cotton industry, one of the large problems to be worked out has been the improvement of transportation. The application of steam power to locomotives on railroads and to steam-propelled vessels on the ocean and on rivers has made possible the shipment of millions of bales of cotton to distant markets. The old modes of traffic on land and water could not have provided for such extensive shipments.



PARTS OF COTTON FLOWER

1. Flower with calyx and corolla removed. 2. Longitudinal section of fruit. 3. Cross-section of ovary. 4. Longitudinal section of ovary. 5. Embryo, enlarged. 6. Pollen grain, enlarged. 7. Cross-section of seed. 8. Seed-pod splitting at the top. 9. Unopened boll.

Again, the harbors of seaports and entrances of rivers have required improvement by dredging and by jetties to provide for this trade, as at New Orleans, Mobile, Galveston, Savannah and Charleston. The hydraulic cotton press by which the soft, loose cotton from the gin was compressed into solid heavy bales for shipment has been very serviceable. Finally, the shipment of cotton cloth to all the countries of the world by these improved means of transportation has opened up a world market for American cotton. Cotton is the most important and valuable product shipped by America to other countries, in exchange for their peculiar products.

8. About twenty-five years ago it was discovered that the seed and stalks of the cotton plant were of much value as well as the cotton fibers. The problem of discovering the value of these by-products of the cotton plant has been worked out with great advantage to the cotton farmers.

About two-thirds of the weight of cotton picked from the field is in the seed. Machines have been invented for hulling the seeds and pressing out and purifying the oil. A ton of seed yields 300 pounds of oil, 700 pounds of oil cake and 890 pounds of hulls. A mixed food of oil cake and hulls has proved to furnish a well-balanced ration for cattle and dairy cows. The cotton meal is also an excellent fertilizer. The oil is used for salads, also as a lubricating oil and with kerosene for lighting and for soap-making. Formerly the seed with these by-products was chiefly thrown away. In recent years the by-products from the cotton seed have amounted to about one-fourth of the total value of the cotton crop, or $80,000,000 in one year. In addition to this we may observe that the stalks have been found useful, but perhaps the best use is to plow them under, let them rot and thus help to fertilize the soil.

9. Other vegetable fibers besides cotton are used in cloth-making, especially flax and hemp.

Flax, from whose fibers linen cloth is made, has been used longer than cotton. It is often mentioned in the Bible, and the ancient Egyptians wrapped the mummies in linen cloth. The flax fibers are much longer and stronger than those of cotton and are preferred for toweling, tablecloths, collars and cuffs, handkerchiefs, laces, strong thread and fishing lines, and for linen dresses and skirts. The linen fibers are taken from the inner bark of the flax plant, the woody portions having been rotted off and removed.

Flax is chiefly produced in certain countries of Europe, especially in Russia and Ireland. The fields of central Russia are largely given to the raising of flax, and great quantities of flax fibers are shipped to other manufacturing countries to the mills. From the factories of Europe fine manufactured linens are shipped to all parts of the world. In the north of Ireland are large linen mills which have long been famous for the fine qualities of linen they produce. Many of the fine laces of Belgium, France and Holland, which are imported to the United States, are made from Russian flax.

The United States produces considerable flax, not for the fibers, but for the flax seed, which is pressed for oil, linseed oil being much used in paints, oilcloths, etc.

The processes of spinning and weaving are like those in cotton goods, and the inventions of machines for spinning and weaving cloth are essentially the same for all kinds of vegetable fibers.

10. Another plant that produces a most important fiber is the hemp. The chief source of hemp fibers is the abaca or hemp plant which grows abundantly in the Philippines. It is a tree-like plant much like the banana, growing twenty or more feet high, and, like the banana, its central stalk is surrounded with leaves. The soft inside leaves contain the hemp fibers, which must be separated from the soft pulp of the leaves.

These long, stout fibers are collected in bundles and shipped to other countries for the manufacture of ropes, twine, hammocks, canvas, carpets, hats and a great variety of goods. These fibers are mixed with other fibers to make hats, veils, curtains and cloth. Mixed with silk, hemp produces delicate crepes and veils.

A different kind of hemp is produced chiefly in the bluegrass region of Kentucky. The inner fibers of this tall plant are used for making thread, rope, sail cloth and homespun goods. It is treated much like flax and is of great importance in the trade.

Several other vegetable fibers found in different parts of the world may be studied and compared with flax, hemp and cotton. Among these are the ramie, which is much like hemp and is chiefly grown in China. In India the jute plant, very similar to flax, is used for making coarse bagging, also rugs and carpets. These fibers are also mixed with cotton, flax or silk for making cheaper grades of cloth. The coarse bagging used in baling cotton in the south was chiefly made of jute from India.

11. Of almost equal importance with cotton and other vegetable fibers mentioned is the use of wool for the manufacture of cloth and clothing. Wool is an animal fiber obtained from the backs of sheep, goats and other animals. It has been used for the spinning and weaving of cloth from the most ancient times. The processes of spinning and weaving have been nearly the same in cotton and wool. The great inventions have had the same effect in both cases. Woolen cloth is warmer and it is also more durable and expensive. In many kinds of cloth cotton and woolen fibers are mixed.

Europe is the chief center of wool-production and manufacture for the world, but wool is produced extensively also in the United States and in Asia, and the three great wool-growing regions of the southern hemisphere are Australia, South Africa and the plains of the La Plata in South America. The chief woolen-manufacturing centers are in Europe and the United States The transportation of wool from the wool-growing countries to the manufacturing centers is, like the transportation of cotton, one of the most important items of ocean traffic. Great steamship lines are employed chiefly in this transport.

A comparison of the location of the great cotton-growing districts of the world with the wool-producing countries will show that wool is grown farther north or south of the equator than cotton. Cotton also is chiefly used for clothing in warmer lands, while wool is more extensively used in colder regions.

12. A third important material used in making cloth is silk, which is obtained from the cocoons of the silk worm.

In China, Japan and India silk goods are turned out in large quantities. The old-fashioned hand looms are still in use in these eastern lands.

In Italy and France raw silk and the finest silk goods are made in vast amount and shipped out over the world.

Paterson, New Jersey, and New England in this country are now producing immense quantities of silk goods. The processes of spinning and weaving in the large mills are similar to those of cotton and wool.

The production of cotton, woolen and silk goods in many parts of the world constitutes the chief part of what is called our textile industries.

13. There are also two other important ways of manufacturing these fibers into clothing, known as knitting and lace-making. In modern times knitting and lace-making machines have been invented which are almost as ingenious and important as the spinning and weaving machines. Great factories in America are also employed in knitting and lace-making.

In a little more than a hundred years the remarkable inventions already described in the various textile industries have vastly increased the quantity of goods and greatly reduced the price of them for the people. The common people are thus enabled to clothe themselves more comfortably and attractively than in former times.

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COFFEE

Suggestions as to Method

(*a*) The study of coffee, tea and chocolate, as to countries in which they are produced, the regions of the world in which they are used and the traffic routes by which the exchanges are made involves a good share of the lands and seas of the whole earth.

(*b*) This study involves a treatment especially of tropical and subtropical lands and islands in both hemispheres and on both sides of the equator. The great belt of equatorial and semitropical lands and seas comes under this study.

(*c*) A series of pictures is needed showing not only coffee and tea plantations with their orchards, buildings and processes of cultivation and treatment of products, but also the trees and vegetation peculiar to the warmer lands.

(*d*) Incidental to this study of productions comes a study of the peoples of these warm countries, and their dress, customs and modes of life.

(*e*) Specific drills are desirable in the naming and location of countries, islands, cities, seas and ocean routes.

(*f*) We have now excellent supplementary readers which give a fuller and richer treatment of these topics than can be presented in this text, with excellent maps and pictures.

(*g*) The comparisons of the regions devoted to tea, coffee and chocolate and of all the processes of preparation of products should be regularly encouraged.

Outline of Topics

1. Where we get our coffee.
2. A coffee plantation in Brazil.
3. Planting and growth of coffee trees.
4. Gathering the coffee berries.
5. Processes of removing the coverings of the seeds.
6. The coffee market at Rio Janeiro and at Santos.
7. The countries where coffee is produced.

8. Coffee-using countries.

9. Tea-production and use throughout the world.

10. Chocolate. Regions where it is produced and raised.

11. General summary regarding these three products of the warmer zone.

A COFFEE PLANTATION

1. Nothing that we eat or drink is more common on our breakfast table than coffee. Many people have such a habit of drinking coffee that they would scarcely know how to breakfast or dine without it. But coffee comes a long distance across land and sea and usually from beyond the equator before reaching our breakfast table. The people who raise coffee for the market speak a different language from ours. They live and dress differently from us, and they would not feel at home at our breakfast table, even where their coffee is served.

Should we travel back over the same route by which coffee has made its way from the coffee plantation to our homes, we should find the journey a long and changing one. It would bring us by railroad to New York or Baltimore and by steamship travel to Porto Rico or to Rio Janeiro, S. A., and from there two or three hundred miles up into the warm hill country of Brazil. We would travel through tropical forests, palms and banana groves, and up steep mountain roads into what might be called the backwoods of Brazil.

2. A coffee plantation in southwestern Brazil is much larger than our Illinois farms. The largest plantations cover several thousand acres and are as extensive as some of our big western cattle ranches.

In the upland, hilly and mountainous parts of Brazil, southwest of Rio Janeiro, there are many of these great coffee plantations, which are owned and managed by wealthy proprietors.

Such a plantation, like one of the large tobacco or cotton plantations in the South before the war, is like a small state, ruled and managed by the owner. He sometimes employs several thousand people upon a single plantation. At some convenient place on the estate he will have large buildings both for dwellings and for the extensive machinery required, long low sheds connected with broad cemented areas where the coffee berries can be dried in the sun and protected from rain and heavy dews. There are also scores of cottages for the working people and families. There are also large barns and storage places for the machines used on the plantation. There is usually a carpenter shop and a blacksmith shop, a sawmill and a brick kiln. Often a sugar-cane mill and a mill for grinding corn are found on the plantation. For all these are needed to produce lumber, brick and food materials required by many hundreds of people. It is necessary also to have a large store where laborers and their families can buy the many articles of food and clothing not produced on the plantation. Roads must be built in all directions over the farm, and sometimes tracks are laid for private railroads over which the coffee is hauled and collected at a central station.

The manager of such a large coffee estate has his hands full in overseeing so many people, with such a variety of shops, machines, storehouses and separate fields.

Besides others, he needs a large number of clerks and bookkeepers to secure a close and accurate account of the whole business. Formerly negro slaves did the common work on the plantations, but slavery was abolished in Brazil some years ago and now Italians are sometimes employed instead. But negroes are also numerous as laborers on the plantations.

3. Getting a large coffee plantation started is costly and laborious. The heavy growth of trees and brush has to be cut away and burned. As soon as the ground has been cleared we find a very red soil, about the color of dark red brick dust, which is very rich and favorable to the growth of the young sprouts and trees of the coffee plant. The coffee seeds are first planted in nurseries and when about a foot or more high are transplanted to the hillsides where

they are carefully cultivated, weeds pulled out and the ground plowed. Between the rows, the first year or two, corn and other crops are raised. In four years the trees grow to a height of six feet, and in the fifth and sixth years they begin to yield good crops, three or four pounds of coffee to a tree. Such a field may continue to bear for thirty years and longer. The coffee trees gradually exhaust the soil, so that in planting new fields, new forests are cut down and new and virgin soil secured. The old fields are often abandoned, and much of the coffee country looks deserted and waste.

LEAVES AND FLOWERS OF THE COFFEE PLANT

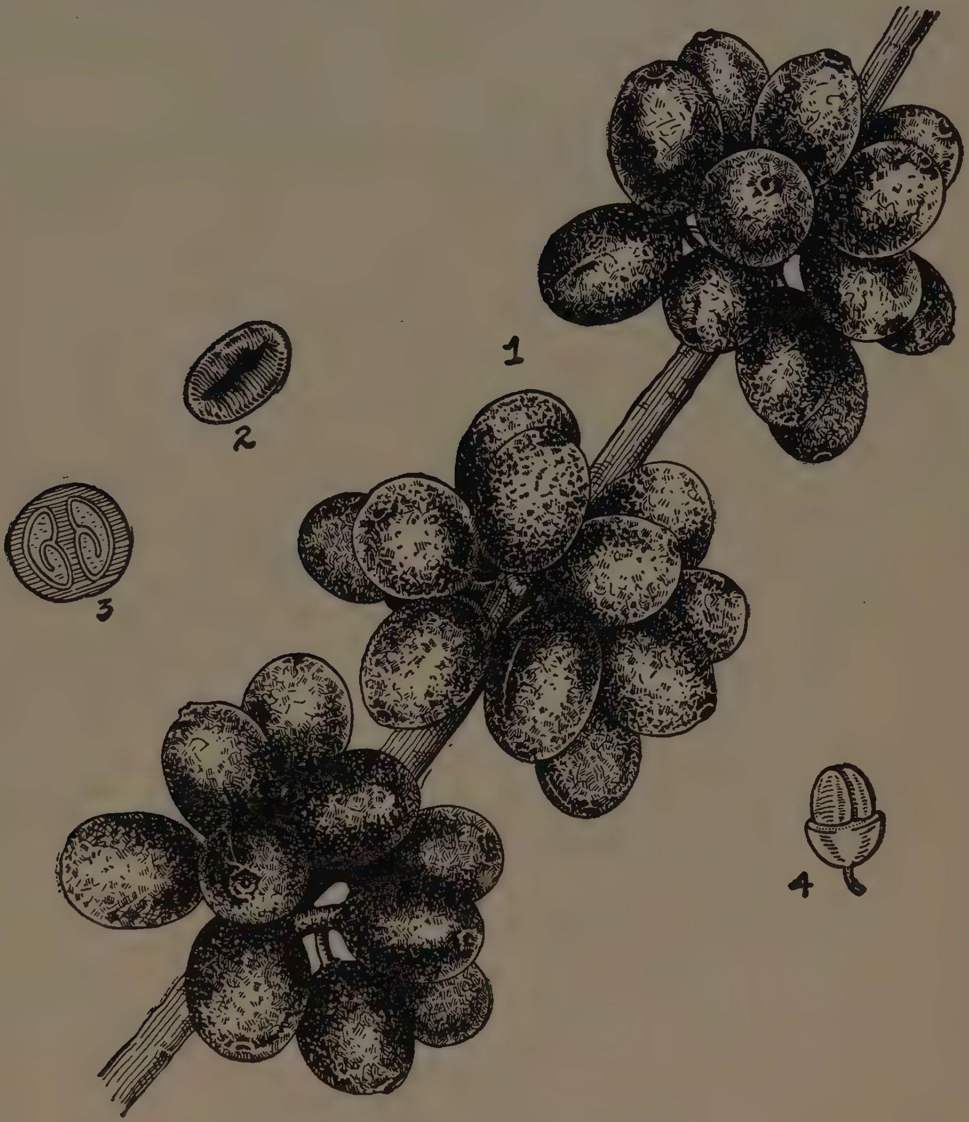
The coffee plantations require a warm, moist climate where no frosts occur, but not too warm and not a scorching sun. This favorable climate is secured in the Province of Sao Paulo, where the hillsides furnish the right combination of warmth, moisture and soil. These hilly lands lie from one to three thousand feet above sea level in the semitropical belt of Brazil.

4. The time for gathering the coffee is in April and May. The red berries grow in clusters close to the branches and are about the size and color of a dark red cherry, or somewhat larger than cranberries.

When the crop is ready to harvest, the pickers by thousands go out into the coffee groves to pick the berries. Men, women and children gather them in baskets and carts, and cars collect the results of the pickers' work and haul them to the mills. A single picker working from sunrise to sunset may gather enough to make fifty pounds of hulled coffee. On a single plantation there may be 5,000 pickers at work. The largest coffee plantation in Brazil has about five million trees. On such a plantation there are many coffee orchards in all stages of development, from the freshly planted trees to old orchards twenty feet high. New groves are set out each year. On the largest plantations the berries are collected and hauled in to a central station from all parts of the plantation by engines and trains of cars.

5. The coffee berry has three coverings, the fleshy outside pulp, and two inside, close-fitting skins. The outside fleshy covering is crushed and softened by passing between rollers and then is easily removed by whirling and churning it in water. The heavier seeds drop through small holes in the revolving cylinders and are collected. They are then subjected to a scouring and rubbing which leaves them smooth white berries with nothing but the two inner coverings. These white berries are spread out on broad cemented areas and exposed for many days to the hot sun till they are thoroughly dry. During this period of about sixty days, they are raked and rolled, shoveled together and spread out again so as to expose them thoroughly to the sun. They must be covered and protected against rains and dews. It is a long and laborious process of drying.

An improved modern method used on some large plantations requires steam heat. This artificial process of quick drying requires only a few hours and does not expose the coffee to the danger of rains and dews. It demands somewhat expensive heating and machinery, but it saves time, requires far less labor and somewhat improves the quality of the coffee. After the berries are thoroughly dried they are passed through a series of machines which crack and



COFFEE BERRIES AS THEY GROW

1. Clusters of berries. 2. Ripened berries. 3. Cross-section of fruit. 4. Fruit cut to show the berries

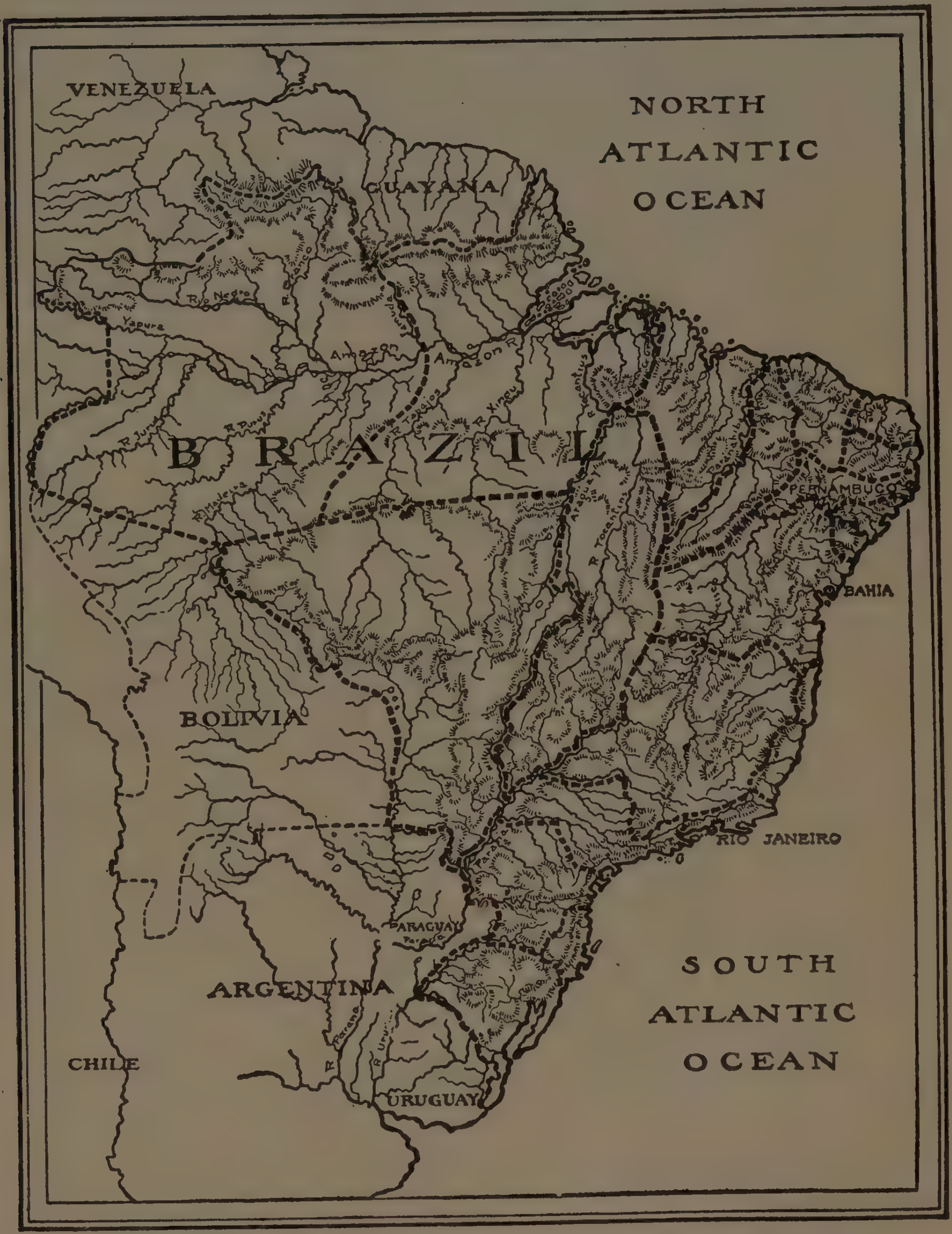
loosen the thick parchment cover so that it can be shelled off, and after that the delicate inner lining called the silver coat is loosened and blown away by a fan. The inner bean consists usually of two coffee kernels with their flat sides together. The mill machinery for separating the coffee kernels from the two inner covers is complicated and hard to describe.

The green coffee kernels, when properly sorted according to size and quality, are shoveled into sacks and shipped to the markets.

6. The Brazil coffee in sacks, weighing each 132 pounds, is loaded upon trains for the two chief points of export, Rio Janeiro and Santos. Along the wharves at Rio Janeiro are great warehouses and coffee factories where coffee is the main staple upon which the commerce of the city depends. All that section of the city is given up to the coffee business. The streets are full of wagons loading and unloading the coffee bags, which are piled up by thousands. In large rooms of the warehouses the coffee is also poured out and sorted and then shoveled into sacks. The noisy factories near by are at work hulling and cleaning the coffee berries which are not ready for shipment. In the harbor lie ships from many parts of the world loading with coffee. Twenty different lines of steamers carry cargoes of coffee to Baltimore and New York, to Liverpool and London, to Hamburg and Lisbon, and to many other cities. Hundreds of negro workers run back and forth to the ships carrying the heavy coffee sacks. Other ships are loaded by cranes which lift a whole batch of coffee sacks at once.

This is probably the greatest coffee market in the world. The air is filled with the odor of coffee and the people and merchants are talking most of all about the qualities and prices of coffee. Ships from foreign lands bring to Rio Janeiro many kinds of goods used by the planters and other Brazilians in exchange for coffee, as lumber from Maine, codfish from Gloucester, Mass., rice from India and cotton goods and machines from England. It is this trade which has caused

Rio to grow into a great city. The city of Santos, the port of Sao Paulo, is about equally important with Rio Janeiro



THE LEADING COFFEE-PRODUCING COUNTRY OF THE WORLD

for the coffee trade and has many ship lines to foreign parts.

7. The coffee-producing countries of South America are not limited to one province of Brazil. Nearly all parts of

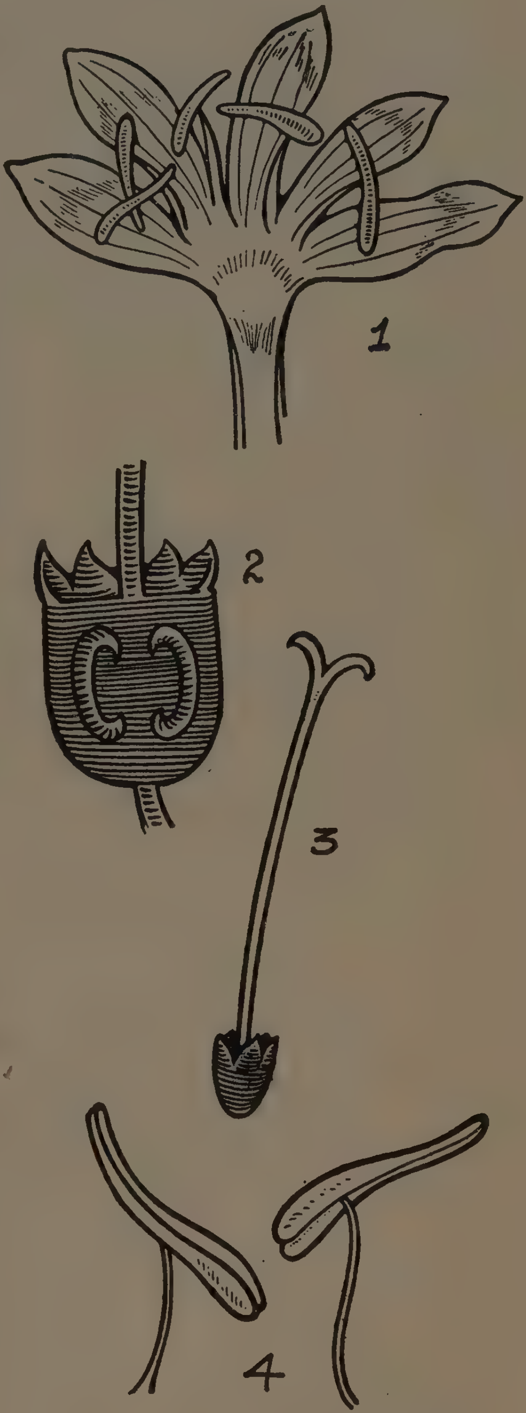
Brazil, even the hot regions of the Amazon, produce coffee, but in different ways according to climate. In Venezuela there is extensive production of coffee of a superior quality. On account of the intense heat in Venezuela the young coffee trees are protected under the shade of bananas and other quick-growing trees, which rise above the coffee bushes and shelter them from the sun. The coffee of Venezuela is also shipped to Europe and America and sold as of the best quality, even as a substitute for Mocha. Besides Venezuela, Colombia and Peru are important coffee-producing states of South America.

The West Indies, Mexico and Central America produce a large amount of coffee for the general world market. On the hills and mountain slopes of Cuba, Haiti, Jamaica and Porto Rico coffee plantations are numerous. At one time Jamaica produced a large amount of coffee, of a superior quality. All the Central American countries are adapted to coffee production, and they with Mexico supply for export yearly about two hundred million pounds.

The South American states which lie on both sides of the equator and those parts of North America and the West Indies which lie in the subtropics are the great centers of coffee-production for the world. Out of the 2,300,000,000-pound coffee crop of the world, about 2,100,000,000 are produced in the tropical and subtropical regions of the Americas. (See Carpenter's *Industrial Reader*, page 299.)

The other chief centers of coffee culture are Ceylon, Sumatra, Java and other East Indian Islands, Madagascar and other islands of the Indian Ocean, North Australia, and some of the warm parts of Africa. Abyssinia is supposed to have been the original home of the coffee plant, and Arabia, near by, for a long time produced the finest quality of coffee, known as Mocha. A study of the world map will show that the home of coffee is in the tropical and subtropical countries of the world. While Brazil is at present the great producer beyond all other countries combined, it is probable that in the future many other warm countries in Africa and both the Indies will greatly increase their product and thus compete with Brazil in the world market.

8. Coffee is, of course, extensively used in Brazil and other countries where it is produced, but it is sent in shiploads to colder countries, and especially to the United States. The United States, by the acquisition of Porto Rico, the Hawaiian Islands and the Philippines, now possesses territories where coffee of good quality is produced for the market. There is probably no part of the United States proper which is warm enough for the production of coffee, but the people of this country are the largest consumers of coffee of any people in the world. It amounts to about twelve pounds yearly for each person in the United States. It would be well then if we could produce a part of this immense quantity in our own territories. The European nations are also large consumers of coffee, especially the Germans, and in a less degree the English, Dutch and Austrians. In Germany it is often adulterated by grinding it up with chicory root, which is much cheaper. Some perhaps prefer the mixture.



PARTS OF THE COFFEE FLOWER
1. Longitudinal section. 2. Longitudinal section of ovary and calyx. 3. Pistil. 4. Stamens

9. Next to coffee the most important drink at our tables is tea. It has been used as the common drink in China and Japan for hundreds of years, and today these are the two chief tea-drinking nations. They consume yearly about two billion pounds more than all the rest of the world together.

In the last hundred years tea has been extensively cultivated and exported from India, Java and Ceylon. It is shipped in swift steamers to Europe and to the English colonies over the world. Among the white races, the English in Great Britain and her colonies are the principal tea drinkers. It is evident, therefore, that tea is produced almost entirely in eastern countries, in subtropical and in the warmer temperate regions. As compared with coffee it is not so widely cultivated throughout the warmer regions, but it is cultivated farther north than coffee. A successful tea plantation has been carried on in South Carolina.

In China and Japan the tea gardens are small but very numerous, so that they cover whole regions. In India and Ceylon there are large plantations employing hundreds and even thousands of pickers on a single estate.

The tea plant is a bush that grows to a height of fifteen or twenty feet, but is kept closely pruned so that it does not stand more than five or six feet high. The young plants are put in rows in a rich soil and carefully cultivated, and begin to be picked of their leaves when three years old. The young green leaves are picked three or four times a year and the first pickings are the best. The tea commonly used is made from the young and tender leaves and buds, which are picked, dried and rolled either by hand or in machines. When thus rolled up the leaves look like little green worms. The leaves are then roasted in pans either in ovens or by a hot blast. When thus fully prepared and the stems picked out, the tea is packed in boxes lined with thin sheets of lead to protect it from the sea dampness in ocean shipments. This salt sea dampness easily destroys the quality of the tea. The finest qualities of tea are produced in China and Japan, where tea-drinking is a marked national custom.

In comparing tea and coffee production, we notice that the great centers of cultivation for tea are in eastern lands, as China, Japan and India, while the centers of coffee production are in the western hemisphere, in South America and the West Indies, Mexico and Central America. It is, however, curious to note that Java, Ceylon and India are remarkable for the production of both tea and coffee.

10. A third important drink, which has grown in popularity throughout the world in modern times, is chocolate. Like tea and coffee it is a tree product yielded by the cacao tree of tropical lands. It is a native of Mexico and Central America and is raised in groves which are protected from the heat by loftier trees. The numerous berries grow in large oblong pods, which may contain as high as thirty or forty seeds. These pods grow close to the trunk and branches of the trees, and are clipped off by knives fastened to the end of long poles. Each of the beans has a hard shell that has to be cracked and separated from the kernel. This inner kernel is then ground up, most of the oil pressed out of it and then molded into flat cakes, wrapped and shipped. The oil is called butter. Chocolate is not only a refreshing drink, but has also nutritive qualities which make it more of a food than either tea or coffee.

At the time of the discovery of America, it was a favorite drink with people of Mexico and Peru, especially among the higher classes and in the palace of the Montezumas. The chocolate berries were esteemed of great value. The Spaniards introduced it into Spain, and for a while its proper preparation was known only to them. In more recent times it has come into common use as a delicious drink in Germany, England, Holland, France, etc.

The pure chocolate is mixed with sugar to make sweet chocolate, and is used with vanilla flavoring and in the manufacture of choice candies, cakes and other confections.

On account of the growing demand for chocolate, its cultivation has been extended to the tropical parts of Africa, to the East Indies, Java and the Philippines and to islands of the Pacific, as Samoa and Hawaii.

11. The three most popular beverages for table use throughout the world are coffee, tea and chocolate. They all came originally from tropical countries and are still chiefly produced in the warmer lands. But their common use has extended far and wide throughout the temperate and colder regions of the world. This has given rise to an immense traffic, chiefly by the great sea routes, and carried on by a large number of steamship lines. The tea trade in Asia involves also important caravan routes between China and Russia.

These three products are good illustrations of the natural interchanges between the colder and warmer parts of the world, due to natural differences in production. The colder countries send into the warmer lands many manufactured articles in exchange for coffee, tea and chocolate.

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IRRIGATION

Suggestions as to Method

(*a*) Irrigation on a large scale, under government control, is the main idea developed in this topic. This is a scheme of improvement which is rapidly developing at the present time, and is supplementary to the extensive private irrigation which has been in process of growth during the last forty years.

(*b*) A full description of one of these projects, illustrated with diagrams and pictures, will plainly demonstrate the principles upon which these large irrigation schemes are worked out.

(*c*) The government reports and the advertising circulars of western cities, railroads and land companies furnish excellent maps and pictures.

(*d*) A full comprehension of one of these schemes requires a vivid exercise of the imagination in constructing the whole plan upon which the dam and ditches are based, so as to deliver the required water to the land.

(*e*) A great variety of irrigation methods is employed and a comparison of these various plans as to efficiency and results requires a vigorous process of thinking.

(*f*) Drill upon the important series of rivers, states, cities dependent upon irrigation, lakes and irrigation districts, till they are well fixed in memory.

(*g*) Let the children study the maps thoroughly and learn to sketch the projects and irrigation districts.

(*h*) On the basis of the outline of topics let the pupils give full oral reproductions without help from the teacher's questions.

Outline of Topics

1. Government projects and irrigation.

2. The irrigation dam in the Salt River basin.

3. Various phases of the project. The road from Phoenix to the dam. The electric plant. The lumber mills and the concrete mill. The lake. The productive land.

4. The Truckee and Carson project in Nevada.

5. The Shoshone project in Wyoming.

6. The government plans with regard to actual settlers. Provisions of the reclamation laws of the government.

7. Extent and number of the government projects.

8. Extent of private irrigation schemes.

9. Rivers flowing east and west from the Rocky Mountains and furnishing water for irrigation. Mountain valleys. Rocky Mountains as sources of water supply.

10. Lakes and rivers of the Great Basin. The west coast irrigation rivers.

11. Irrigation by wells and by pumping. Rice lands of the Gulf States.

12. The wealth of the arid states.

13. Great possibilities of irrigation.

14. Irrigation in other lands.

THE ROOSEVELT DAM

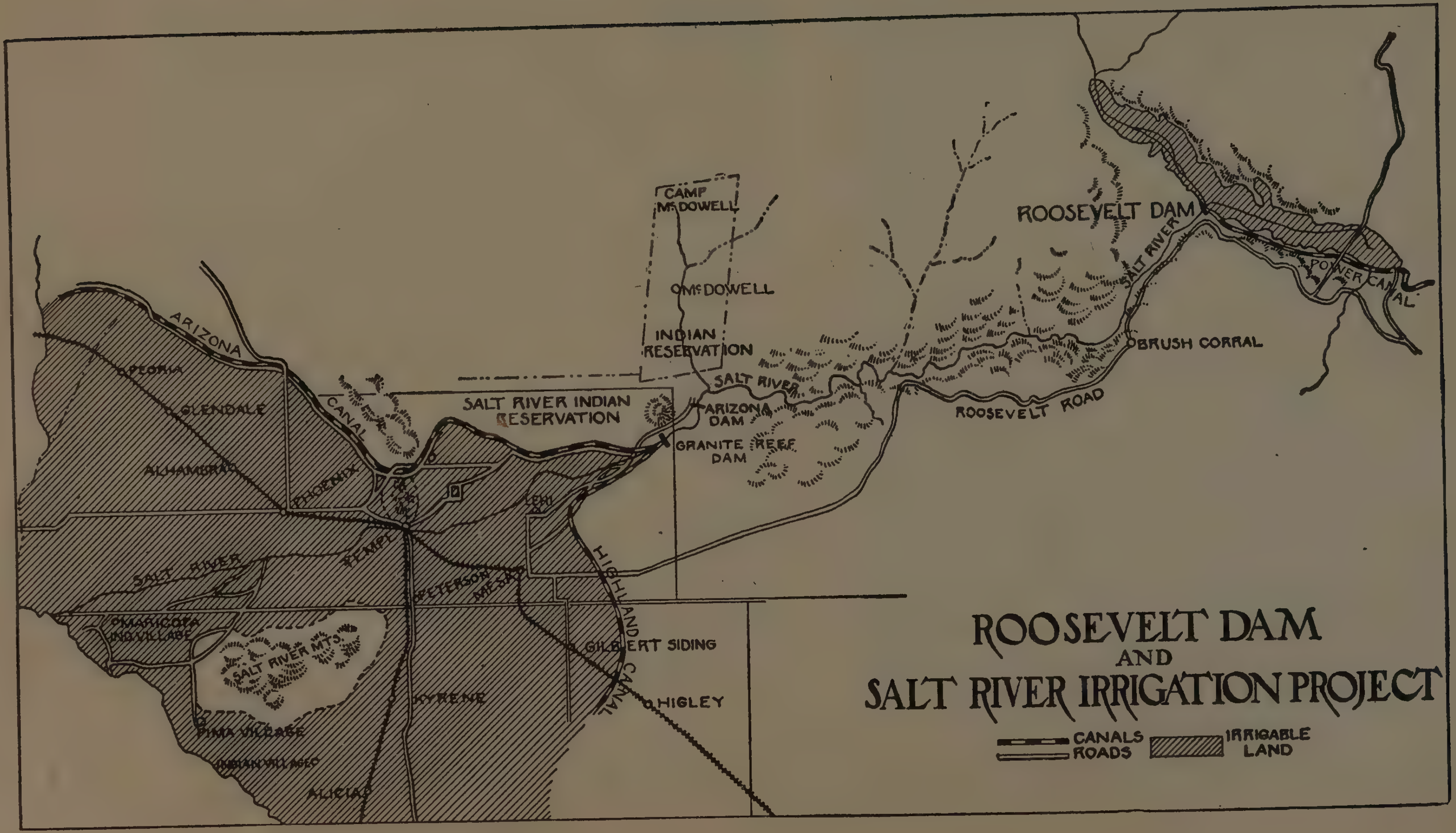
1. In recent years the government of the United States has undertaken a number of great projects for irrigating large tracts of arid land in the west. During the last forty years many irrigating ditches have been taken out along the rivers of the arid states by farmers and by smaller and larger private ditch companies. In this way a vast amount of land in the western states has been supplied with water and many desert regions have been made productive.

But there were some great reclamation projects that required such a vast outlay of money that private companies would hardly undertake them. A law was passed by Congress in 1902 by which the government of the United States provided for a large sum of money which was to be spent in surveys for determining the best sites for irrigation projects, and in then constructing dams, reservoirs and ditches for direct irrigation of these lands chosen. A few of these large irrigation schemes have already reached completion and others are under construction. Such was the Salt River scheme of southern Arizona.

2. This river rises at the foot of the White Mountains in eastern Arizona and flows westward. In its lower course the valley widens out into a broad flat or gently sloping plain. This broad portion of the valley had rich soil and if supplied with water would provide abundant crops.

In the spring of the year this river had large freshets, because of the melting snows on the mountains. The mountains are high enough to receive heavy snows in winter brought by the moist winds from the Pacific. The mountains become thus the reservoirs which collect the winter snows and send them down the valley in spring floods. But these floodwaters passed off down the stream, and in the later dry summer season, when water was in great demand, none was to be had.

The first great question was how to store up these flood waters, and hold them back till they were needed for irrigating the dry lands of the valley in midsummer.



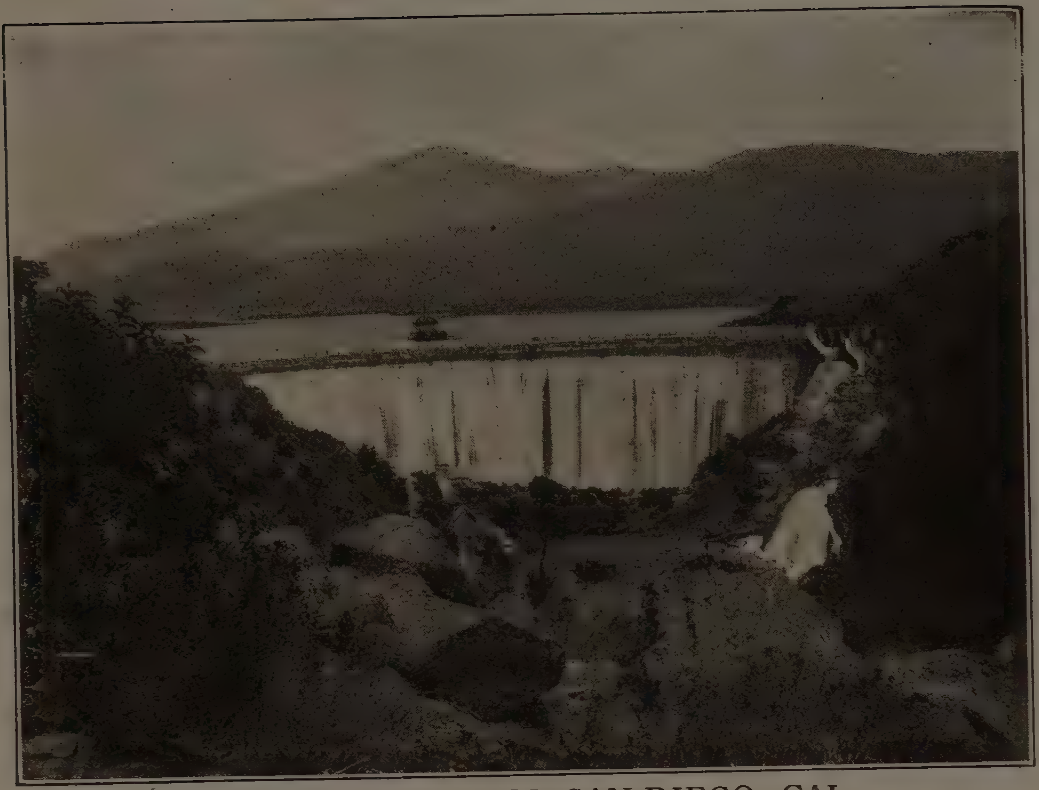
ROOSEVELT DAM AND SALT RIVER IRRIGATION PROJECT

The government engineers, after surveying the Salt River valley to the sources of the stream, decided that it would be possible, though at great expense, to build a large dam across a very narrow part of the valley and thus create an extensive lake above the dam. The spot chosen for the dam was sixty-two miles up the river from Phoenix. Forty miles below the dam the valley widens out into an extensive plain with many thousands of acres of tillable land, wherever water is supplied. Above the dam was also a somewhat broadened valley, which was to be filled with the lake, about twenty-five miles long and from one to two miles wide.

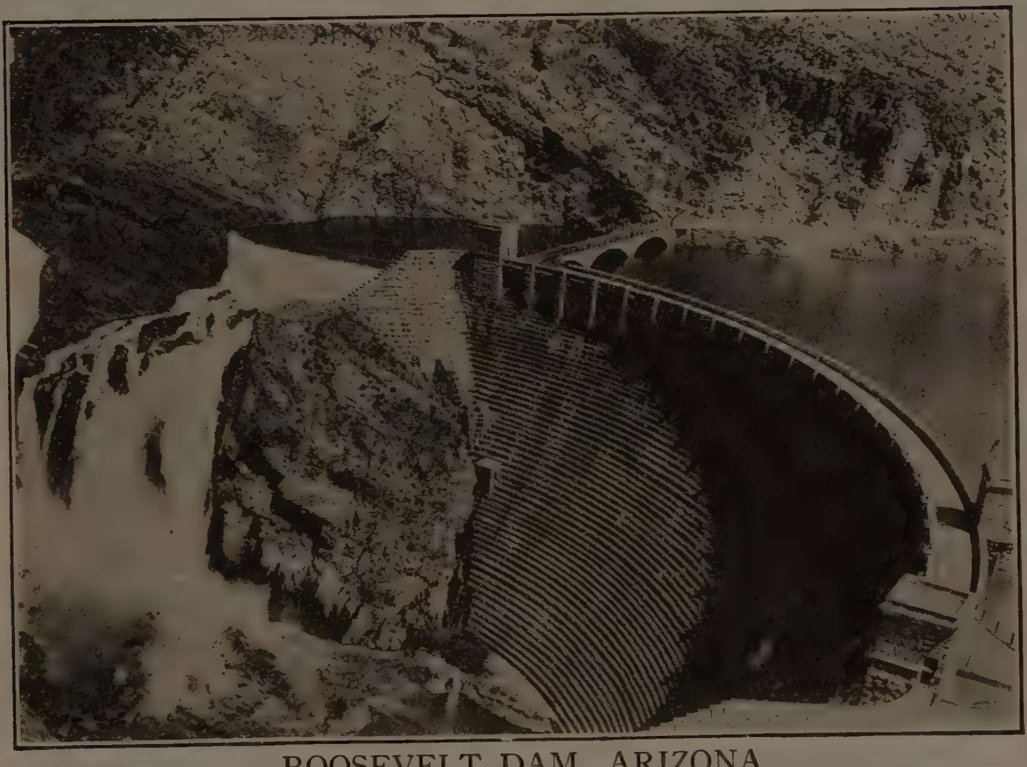
At the point where the government decided to build the dam the river had cut down into the rocks, making a deep, narrow canyon, with high walls. Here the Roosevelt Dam was built, 280 feet high and 1,115 feet long, on the crest. One can perhaps imagine how strong and solid such a dam must be built to hold back the waters of a lake so deep and long. It must be laid deep in the solid rock and built with such a broad base and thick walls that nothing could undermine it or break it down.

3. In order to bring the tools and materials to this spot in the mountains it was necessary to construct a paved road from Phoenix through a very broken and rugged country. The cities of Phoenix, Tempe and Mesa contributed $75,000 to the construction of this fine mountain road. The Apache and other Indian tribes of Arizona furnished an excellent body of workmen for the construction of this road.

In the neighborhood of the dam were found the rock and cement necessary for the construction. This saved the expense of hauling these heavy materials long distances. Here was built by the government a large mill for the production of concrete to be used in the construction of the great dam. On the slopes of the neighboring mountains were found extensive forests. Much lumber was needed in the scaffolding for the building of the dam, and the government set up two large saw mills to convert the logs into lumber. The dam is sixty-two miles from a railway station, and before



SWEETWATER DAM, SAN DIEGO, CAL.



ROOSEVELT DAM, ARIZONA

IRRIGATION PROJECTS

This reservoir holds the largest artificial body of water in the United States. The Salt River Project, of which it is a part, will irrigate 200,000 acres, and it cost about $12,300,000.

work could be begun upon it, it was necessary to construct a road over which to haul machinery and supplies. This road cost $350,000 and it is one of the finest highways in the country.

In the river near the dam was developed an electric plant of some 10,000 horse power which was used in mixing and handling the cement and constructing the dam. The water power of the river was therefore chiefly used for building the dam which checked the river in its course and caused it to form the lake.

With the completion of the dam a lake twenty-five miles long is formed in the season of floods, and the water thus held in reserve may be used lower down the valley during the dry months of summer. The lake contains enough water to cover the state of Delaware a foot deep. Forty miles down stream from the big dam is a diversion dam by means of which the water coming down from the lake reservoir is directed into two main canals, one on each side of the broad valley. These in turn supply smaller canals and ditches which distribute the water to 160,000 acres of land. The irrigated land is divided up into farms of ten acres and more, up to 160 acres.

TRUCKEE-CARSON IRRIGATION DAM, NEAR RENO, NEVADA

This irrigated land is said to be very productive in garden products, in many fruits, as peaches, dates, oranges, grape fruit and olives, in alfalfa and beet roots, and promises rich returns to dairymen and stock-raisers.

A number of large power plants are in operation, the water power being supplied from the lake. These develop about 20,000 horse power which is utilized for pumping water, running machinery, lighting and operating street cars. The water pumped from wells irrigates about 50,000 acres of additional farm lands not reached by the ditches, the canals conveying water to about 220,000 acres in the valley below the distributing dam. The entire expenditure on this project was about $13,600,000 and the annual returns from the crops exceed $4,000,000. There are 3600 farms irrigated, and the valley is one of the most fertile spots in the entire southwestern part of the United States. No better illustration of the effect of water in turning a barren waste into a region teeming with fruit and flowers can be found. Salt River Valley is now the home of thousands of prosperous families, and what has been accomplished by the construction of this great dam, has been repeated in many other localities in the Rocky Mountain region from Arizona to the Canadian boundary. These irrigating works are a striking example of the way in which man has overcome natural disadvantages and made unwilling Nature bow to his will. They are typical of man's conquest of natural forces.

4. On the eastern slopes of the Sierra Mountains in Nevada are the two streams, the Truckee and the Carson, the former flowing down into Pyramid and Winnemucca Lakes and the latter into the Carson Sink. A great engineering scheme was worked out by which the waters of the Truckee River were carried through an artificial ditch into the channel of the Carson River and a great valley reservoir was formed of the double waters in a lake. Below the reservoir the combined waters are carried by large ditches on both sides of the river and distributed to the fertile delta lands. About 350,000 acres are thus brought under irrigation, enough land

to support a population of 50,000 or more. A farm of from ten to forty acres is sufficient to sustain a family.

5. The Shoshone River in Wyoming has an interesting engineering scheme for impounding the waters and for distributing them into the valley below. At the head of a narrow canyon in the river, three and one-half miles long, with steep rocky walls hundreds of feet in height, is built a strong dam 328 feet in height from bed rock below the stream. This collects or impounds the waters above into a large reservoir. In order to avoid too heavy floods sweeping over the dam and overfilling the outlets for irrigation waters, a spillway tunnel is cut around the dam through the solid granite, and the excess of flood water is let out into the canyon below by this tunnel.

From the top of the dam or reservoir a tunnel three and one-half miles long is carried through the rock for a high line canal to irrigate 70,000 acres of table land beyond the outlet of the canyon. Another channel diverts the water from the river sixteen miles below the dam for a low-lying canal to supply the bottom lands of the valley.

6. These three illustrations are sufficient to show the great government undertakings which are designed to reclaim the lands of the west, so far as they lie in the valleys of rivers and can be supplied with water. At the same time small farms and houses are provided for thousands of families of industrious people seeking comfortable homes. It is the purpose of the United States government to work out these large irrigation projects for the benefit of the common people, to divide up these irrigated lands into small farms for actual settlers, who pay for their lands and water rights in yearly payments extending through a period of ten years, and without interest. In this way the government gets back the money it has spent and can use it in new projects. It is not permitted that wealthy men should buy up large tracts of land and hold it for speculation. The whole purpose is to help the common man of small means.

The principal provisions of this law are briefly as follows:

First. A reclamation fund in the treasury, consisting of the proceeds from the sales of public lands in the sixteen arid and semi-arid states and territories.

Second. A reclamation service in the United States Geological Survey to investigate and report on the irrigation projects for the approval of the Secretary of the Interior, who may authorize construction and let contracts, providing the money is available in the fund.

Third. The return to the fund of the actual cost of each project by the sale of water rights, payments to be made in a series of instalments running over a period of ten years.

Fourth. The holding of public lands for actual settlers under the homestead act, in small farm units sufficient to support a family, no commutation to be permitted.

Fifth. The sale of water-rights to private land-owners, but not for more than 160 acres, making land monopoly impossible and forcing the division of large estates.

Sixth. The ultimate turning over to the people of the irrigation works, except the reservoirs, to be operated and managed by them under a system of home rule. The actual users of the water in ten years after the completion of the works will have repaid to the government the amount of its loan without interest. The money so returned may again and again be expended on other works.

7. The government maps of the reclamation service show the location of a large number of these important irrigation projects distributed through the Rocky Mountain States, and through the other states lying in the arid regions farther west. These maps show that all the western states, including the Dakotas, Kansas and Texas, are deriving important benefit from the government efforts to reclaim arid lands. Some of these projects are now completed or nearing completion, others are under way, and others are under investigation by the government engineers.

8. These government projects are only a part of a much larger system of irrigation that has been growing and developing in the western states for many years. For example, in

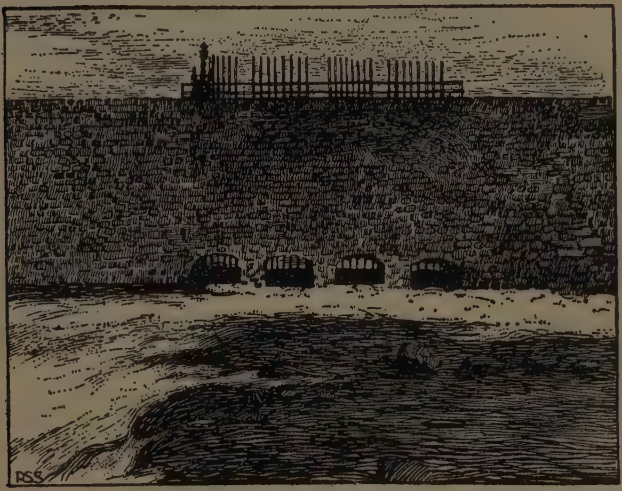
1880 a large irrigation ditch was dug along the South Fork of the Platte to supply the lands just south and east of Denver. This ditch was taken from the river up in the mountains at the outlet of South Park, and it irrigated thousands of acres just east of the Rocky Mountain foothills. It was forty feet wide and six or seven feet deep. Similar large ditches were taken from the Arkansas west of Pueblo to irrigate the mesas and other lower-lying good lands along that river.

Many smaller streams breaking through the foothills and flowing toward the Arkansas and the Platte were dammed to catch the flood waters in the spring. These waters were then led in small ditches along the upper parts of the valleys to irrigate lower-lying lands.

9. The North Fork of the Platte, the Yellowstone and the Upper Missouri, with their dozens of smaller branches, are all irrigation streams whose waters, led out upon arid lands, render them very productive. In traveling through the west one is surprised at the large number of these flat, fruitful, well-cultivated valleys, generally bordered with hills or mountains. Some of these valleys, as in Montana, are a hundred or more miles in length and from ten to fifty miles in breadth, and a few, like the Snake River Valley in Idaho, much larger still.

There is thus a strip of land just east of the Rocky Mountains and foothills, extending from Canada into Texas, about 1,200 miles in length, which has been thus extensively irrigated, and is constantly bringing more land under irrigation ditches. In order to increase the amount of irrigated land it is necessary to go up into the mountain valleys, and, by means of dams in the narrowest gorges, produce great catchment reservoirs or artificial lakes.

The whole Rocky Mountain range, from Montana to Mexico, rises very high, so as to catch and pile up upon the upper slopes the heavy snows of winter, which are brought from the Pacific on the west by the prevailing eastward-moving winds. There is, therefore, with the melting snows and floods of springtime an immense amount of water that can be stored up in these artificial lake reservoirs and then let out upon the fields bordering the streams lower down in summer. The westward slopes of the Rocky Mountains drained by such rivers as the Columbia, the Snake, the Colorado, and their large and numerous branches furnish a second extensive field for large and successful irrigation projects. Examples of these are the Snake River in southern Idaho and the Grand River in western Colorado, both of whose valleys have become almost marvelous fruit-growing districts, as well as rich farming and stock-raising regions.



GATE OF WILSON LAKE RESERVOIR, IN IDAHO
Showing the means by which the flow of water is regulated in dams of this description

10. In the Great Basin, which has no outlet to the ocean, are several considerable rivers which are important for irrigation, e. g., the Jordan and Bear Rivers, flowing into Salt Lake, the Humboldt and its branches flowing into Carson Sink, and several rivers like the Truckee and Carson flowing westward from the Sierra Nevada Mountains. In fact, the Mormons about Salt Lake were the first to discover and show how to convert these dry and barren lands into fruitful fields, orchards and gardens by the process of irrigation.

A fourth very important region for irrigation is that drained by the smaller coastal rivers flowing into the ocean from the states bordering the Pacific, the Rich Valley of Central California, and Southern California, and parts of Oregon and Washington.

11. Another method of irrigation worth mentioning in this connection is that by means of wells. In the western part of North Dakota and South Dakota, in Kansas and Nebraska and in Texas, wells are bored often 1,000 or 1,200 feet deep. Abundant water for a large farm is often secured in this way and is sometimes pumped into artificial basins or lakes which are located and dug out on the higher levels of the farm, whence the water can be carried by ditches to the fields. In Texas about San Antonio and other places this method has been used with marked success. It depends upon abundant supplies of underground water and is at first quite expensive because of the cost of boring the wells and of equipping with pumps or windmills.

This plan of irrigation is also followed in southern New Mexico and Arizona where there are extensive tracts of good dry land for which no river water is obtainable. This mode of irrigation is likely to become more and more important, as there are extensive areas in all the western states to which water from rivers cannot be applied, but which are in other respects good for agriculture.

Still another plan of irrigation is followed in the rice fields of the southern states, in Louisiana, Texas and Arkansas. Formerly only swamp lands were used for such purposes, as along the low coastal swamps of the Carolinas. But in the newer states of the southwest, the prairie lands, so called, are used for rice fields. A high ridge of land is thrown up around the fields and water is pumped up by engines ten or twenty feet from neighboring streams or bayous, and the fields are flooded at the proper time for sowing and cultivating the rice. Of course this kind of irrigation is not due to a dry climate or lack of rainfall, but to the fact that rice grows on flooded lands, and requires large quantities of water which can be definitely controlled at the season for planting.

12. It may not surprise us to find, after this discussion, that the real wealth of the western states is in agriculture and fruit-growing, that the gold, copper and silver mines of

the west are the smaller part of its resources. The population of the mountain and Pacific states is already chiefly dependent upon agriculture, although lumbering, fishing, mining and stock-raising have much importance. The future development of western cities, the increase of population and wealth, will depend mainly upon the growth of agriculture through irrigation.

13. There is absolutely no limit to the products of the soil that can be grown on irrigated lands. Crops that will grow in any latitude where there is plenty of rainfall and which are there cultivated will grow in like abundance on properly irrigated soil. All that is required to produce a bountiful harvest of grains, fruits or plants of any kind is sufficient length of the warm season for ripening and adequate moisture. A good irrigation ditch, with properly regulated flow of water, assures the agriculturist moisture for his crops which answers every purpose of a rainfall of from thirty to forty inches.

It has been stated by officials in charge of the government's irrigation projects that by the year 1925 there will be hardly a square mile of reasonably level surface in the United States now counted among the arable lands but that will be made productive through irrigation.

14. In Mexico also irrigation has opportunities of development similar to those of the United States. In Europe, where agriculture is more carefully developed, irrigation is extensively employed, as in Italy. The arid districts of North Africa, of Egypt, of central Asia, and of India and China have extensive regions where irrigation has been and still is employed. England has spent large sums on irrigation projects in India.

In later geographical studies the processes of irrigation in use in the United States will be found widely applicable.

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CHAPTER SIX

CONSTRUCTION WORK

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REED MATS AND BASKETS

1. Introduction. The chief problems to be considered in the introduction of industrial arts into the public schools are the ability of the teacher to do the work, the equipment which can be provided, and the material to be used.

First, the teacher can learn to do the work by doing it as directed in the exercises here given. Before attempting to introduce even the simplest of these exercises into the school, she should construct the object to be made; and if she encounters difficulties, she should repeat the exercise until she acquires the skill necessary to enable her to teach the class. Second, the problem of equipment is easily solved by the selection of such exercises as require few or no tools, like those given on the following pages. The solution of the third problem is found in the material employed in the constructions given. The expression of thought through wood necessitates a more or less elaborate equipment of tools, and children in the lower grades are usually denied this material. There are, however, mediums through which thought may be expressed by younger children that require almost no tools, and work with them may be carried on in the regular classroom, without disturbing the pupils at work in the various rooms, or in other branches in the same room.

Each set of exercises is entirely separate from the others, and can be taken up without any reference to them. In general, it is wise to begin with those exercises with which you feel you will succeed the best, and which the conditions and the time seem to make most suitable. This lends interest to the work, and also enables the pupils to see that they are working for a definite purpose.

2. Materials. The most familiar materials used in basketry are rattan, tilo and raffia. *Rattan* is a stout cane which comes to us from China, India and Japan. It reaches this country in the crude state, and is then cut up into caning, pith and rattan. The polished outer surface is removed in flat strips, and is called *caning*. This is used in weaving chair seats. The remainder of the cane is cut into flat and oval lengths having an unpolished surface. The part used for basketry, and commonly called *reed*, is the oval part. This reed is sold by the pound and is designated by numbers beginning with No. 0. No. 0 is very fine, and No. 8 is very coarse. No. 1 and No. 4 are best for school use. The price varies according to number, No. 1 costing about 75 cents per pound; No. 2, 60 cents; No. 3, 55 cents; and No. 4, 45 cents.

The material should be soaked for about ten minutes before using. Too much soaking is bad for the reed. It not only discolors it, but also causes it to become very brittle.

Tilo strands are the shavings from a fir tree. These are a Japanese product. The trunk and large branches of the fir tree are steamed, and then, by using a kind of plane, these clever natives cut the wood into long, straight shavings. *Tilo matting* is a soft, pliable material made of the tilo strands. It may be used in a variety of ways, and is as easily worked as cross-stitch canvas. It is a very absorbent material, taking color as freely as any fabric.

Raffia is the outer covering of the palm leaf. It grows in Madagascar, where the natives dry it and twist it into coils, or make large braids of it. It is then baled and sent to this country in large quantities. It is often mistaken for a kind of grass. Nurserymen find it useful for protecting shrubs and young trees from cold.

All of these materials may be purchased of the School Arts Supply Company, Lockport, Illinois, and most other general school supply houses.

3. Preliminary Steps. Basketry should rank high in the industrial arts of the schoolroom. It requires practically no tools, and admits of great variety as to form and color. In the weaving of baskets and mats there are unlimited possibilities in design. Much has been done spasmodically in the way of basketry. The results on the whole have been poor, which is due largely to poor teaching. No pupil should be allowed to take up a second step in weaving until he thoroughly understands the first. He must understand that no basket can be firmly made unless its foundation is right. As far as possible, each child should be so guided in his work that he can answer his own questions after experimenting.

The material used in basketry consists of the uprights, called *stakes*, and the strands woven around the stakes; these strands are called *weavers*. One who has woven understands that in order to weave continuously with a single weaver, there must be an uneven number of stakes. The child does not know this.

To assist the child to answer many questions concerning the number of stakes, the kind of weave, etc., take a small board, any size and thickness, and draw on it a circle not less than 3 inches in diameter; divide the circumference of this circle into spaces ⅞ of an inch apart, and bore holes large enough to receive pieces of No. 4 or No. 5 reed. Slender twigs of willow adapt themselves to basketry, and may be used just as successfully as reed, as shown in Fig. XI.[1] This is not a basket, but it is used to illustrate to the pupils the different weaves, and how the weaving is done. The spaces in the circle should not be equal, as one hole is to hold a peg, which may be taken out in order to get an odd or an even number of uprights.

This arrangement makes it possible for a pupil to answer

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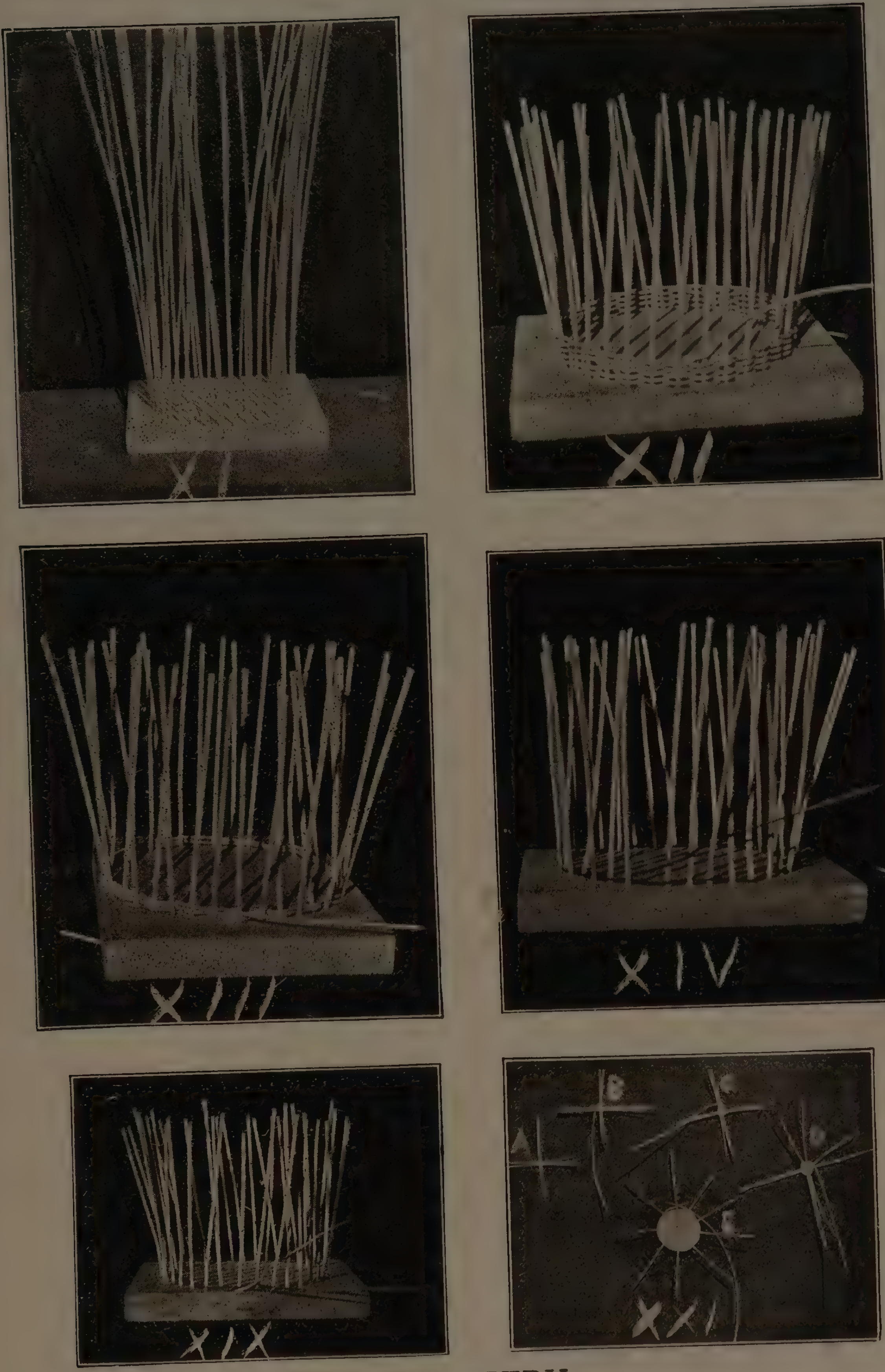
[1] The figures in this and the following sections refer to corresponding numbers in the halftone plates.



BASKETRY

such questions as the following: Why must there be an uneven number of stakes in simple, continuous weaving? Why does an even number give the striped effect in double weaving, when one weaver is colored? How is the Indian weave with an even number of stakes brought about? The same arrangement also makes it possible for the child to make many discoveries in weaving.

4. The Different Weaves. (a) SINGLE WEAVE. Fig. XII shows the single weave, using an odd number of stakes. Fig. XIII shows the single weave, with an even number of stakes. Fig. XIV shows the Indian way of using a single weaver on an even number of stakes. When the weaver gets around to where it started, it passes behind two stakes, and the weaving is continued as before. The next time around, when the weaver reaches the starting place, it passes behind two stakes again. This is true each time around. To make the illustration more easily understood, different colors have been used in order that the course of one weaver may be more easily followed. The reed is easily colored with vegetable or with aniline dyes, using directions as given under *Dye Stuffs* (Sections 21 and 22). Fig. XV shows what may be done in the way of decorations, by using a single weaver and an even number of stakes. At the point marked "2", is shown the way to change from one course to another. Several rows may be woven before changing courses. A band of this style of weaving may be used as the decorative feature of the basket.

(b) DOUBLE WEAVE. Fig. XVI shows the handling of two reeds as weavers. In using two or more weavers, the one at the left hand is known as the *rear* weaver, and the right hand one as the *forward* weaver. Weaving is always done from left to right, except in cases of special design. This will be explained later. In the double weave, two weavers are put behind two consecutive stakes, and project forward to the right. The rear one goes over the forward one and in front one stake, then behind one stake and out between the next pair of stakes, to the right of the forward weaver.

Fig. XVI shows the effect of a double weaving when one weaver is colored, and an even number of stakes are used.

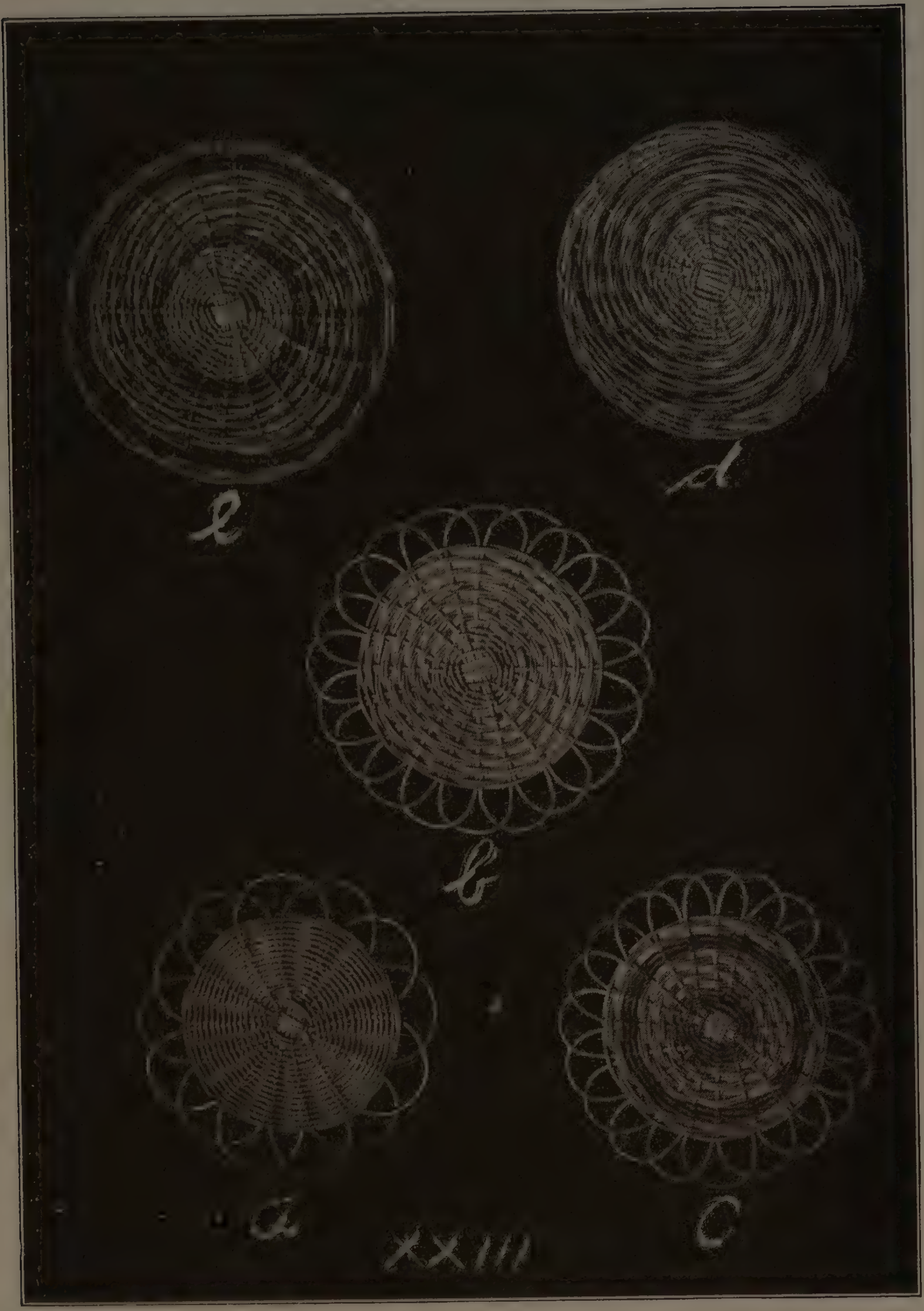
The end of a new weaver is inserted behind and beside the end of the one already woven in. The weaving is then continued. When the basket is finished, these ends may all be cut off flush with either the inside or the outside of the basket, as the case may be. New weaves are introduced in the triple and quadruple weaving in the same manner.

(c) TRIPLE WEAVE. Fig. XIX shows the beginning of the triple weave. The weavers are arranged behind three consecutive stakes and project toward the right. The rear one goes over the other two and in front of two stakes behind one stake, and out between the next pair of stakes, to the right of the forward weaver. The one that was the middle weaver now becomes the rear one, and it, in turn, is treated as the rear one was. Always be sure to take the rear weaver and bring it out between the pair of stakes, to the right of the forward weaver, Very effective results are produced in the triple weave when the number of stakes is exactly divisible by three, when the number of stakes is divisible by three with a remainder of one, and when the number of stakes is divisible by three with a remainder of two. Ample opportunity for experiment should be given.

(d) QUADRUPLE WEAVE. The quadruple weave is done the same as the triple weave, only four reeds are inserted. Very interesting results are obtained by weaving one, two or three colored weavers.

Fig. XX shows finished baskets.

5. Mats. To put into actual practice what has already been given, plan to make a mat, as this embodies all the constructive features found in the bottom of a basket. Soak a No. 4 and a No. 2 reed until both are pliable. From the No. 4 reed cut four 12-inch spokes and one 7-inch spoke. With a darning needle split three of the 12-inch spokes in the center. This is done by boring the needle through the reed and then pulling it so it splits the reed. These incisions must be long enough to allow the remaining number of



MATS WOVEN FROM REEDS

(*a*) Simple weave; (*b*) Indian weave; (*c*) Indian weave with border; (*d*) triple weave; (*e*) weave with colored bands.

This work is of material that can be obtained with little or no expense, and it can be done successfully in any school.

spokes (three) to pass through them. Push half the length of the remaining two 12-inch spokes through the three incisions, as shown in Fig. XXI (a). The four spokes, now in groups of two, are lying at the right angles to each other, forming upper, lower, right hand and left hand groups.

Place the 7-inch spoke between two of the 12-inch spokes, pushing it just through the incisions, as shown in Fig. XXI (b). This gives the odd number of spokes necessary for plain weaving. The end of the weaver of the No. 2 reed is pushed through the incision, as shown in Fig. XXI (b). The weaver is then brought to the right, in front of the vertical group, back and down behind the horizontal group, thereby binding its own end to the spokes. It then comes to the left, across the vertical group, back and down behind the horizontal group to the left, back to the place from which it started. It follows the same course once more, until it has been around the group twice, as shown in (c). The next time, instead of coming down across the group of horizontal spokes to the right, it breaks back, or is reversed, over the horizontal group to the left, and follows the opposite course around twice. The next time around the spokes are separated and the under and over weaving commences, as shown in (d). If one weaver is too short to bring the weaving to the desired size, join the weavers as shown in (e), and continue the weaving as though the weaver were continuous. Be careful to keep the weaving close together, with the left hand, each time it goes over and under the spoke.

Fig. XXII shows the way the mat is held with the left hand in the beginning of the work, while the right hand does the weaving. Be sure to hold the spokes out straight. The weaver must adjust itself to the spokes, and not the spokes to the weaver. When the spokes are all the same distance apart, and approximately in the same horizontal plane, the weaving is placed on the flat surface. The spokes are held down with the left hand, and the weaving is done with the right. When the weaving is completed, the edge of the mat is overcast. To do this, first cut off the weaver long enough to go a little more than once around the circumference. Begin overcasting, as shown in the illustration, by bringing the weaver from behind one spoke, over the next spoke to the right, and through the last row of weaving just before it gets to the following spoke. Continue this process until once around, then cut off the weaver back of the last spoke.

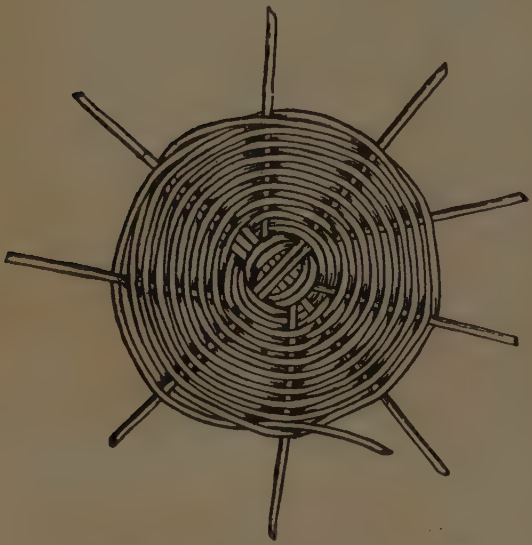
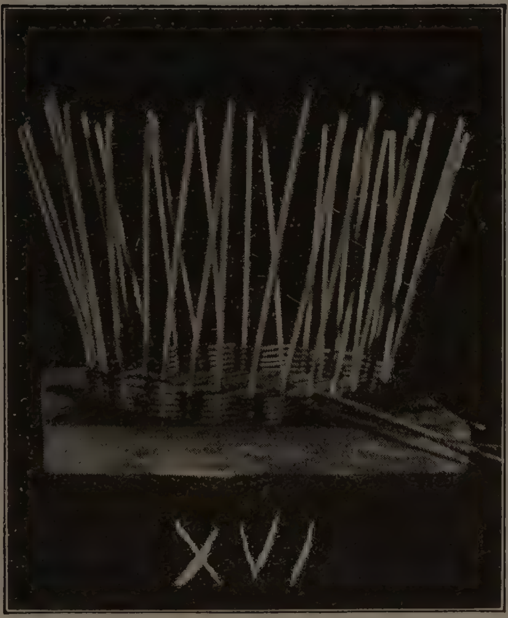


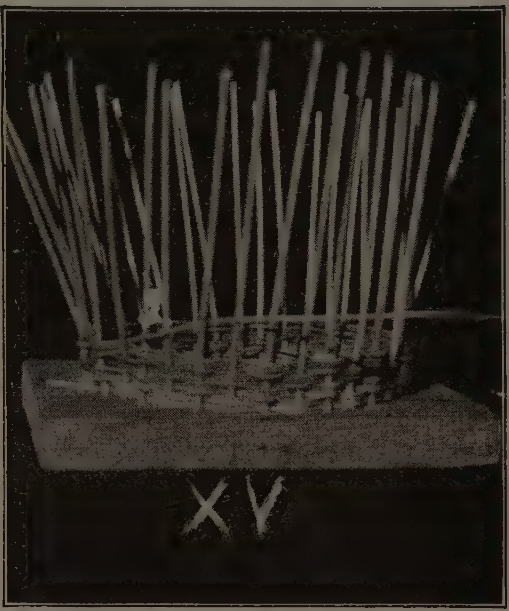
ILLUSTRATION OF OVERCASTING

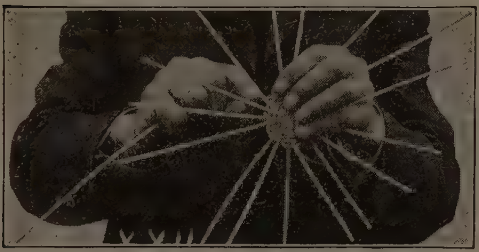
The mat is now to be finished with an open border, as shown in Fig. XXIII (a).

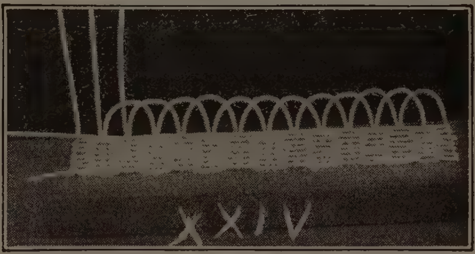
Fig. XXIV shows a very simple way of illustrating to a class how open borders are made. Looking from right to left, we find in the illustration that one spoke goes in front of the next, and inserts just before it gets to the third. If the spokes are about one inch apart, it will require about 2¾ inches, outside of the overcasting, to finish the border. A very effective border is made where the first spoke goes in front of the second, and inserts just before it gets to the fourth. This requires about 4½ inches outside of the overcasting. A third finish allows the first spoke to go in front of the third, and insert just before it gets to the fifth, and requires from 6 to 7 inches beyond the overcasting. In each case the end must be sharpened and inserted 1 to 1½ inches.

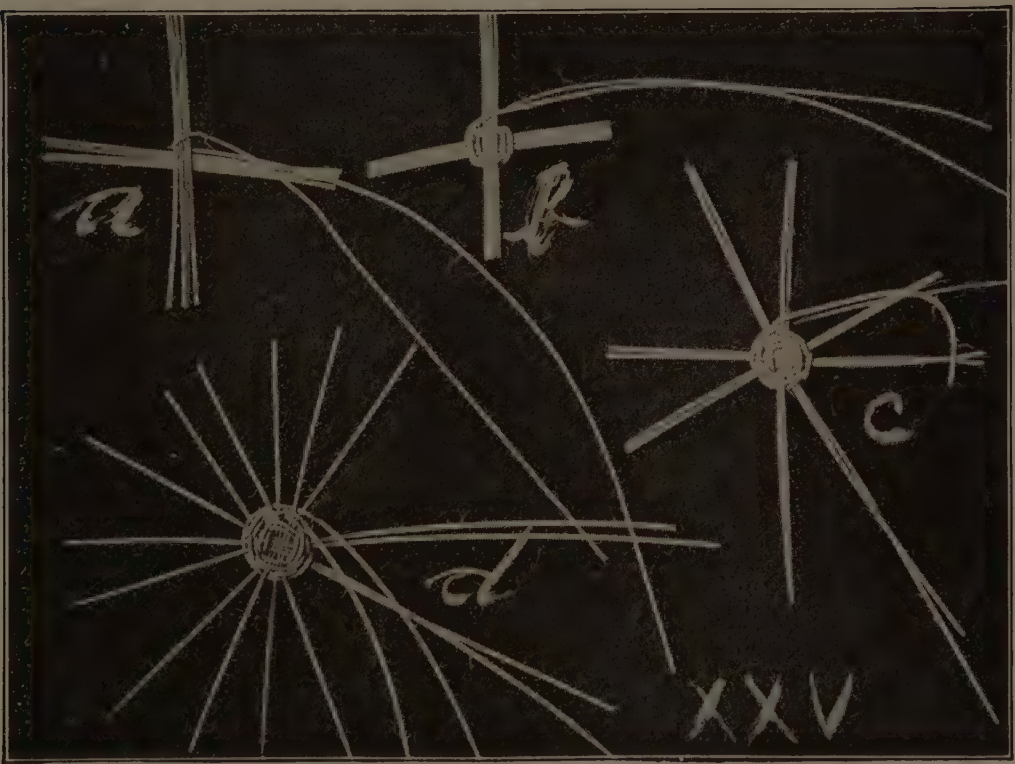
Fig. XXV shows the method of starting a center with the pairing weave. Half the reeds are split, and the other half are pushed through these incisions to form a perpendicular cross, as shown in Fig. XXV (a). The weaver is pushed through the incision, so that one-half is to the right of the vertical group, and the other to the left. The split pieces are held vertically, and the weaver, doubled in the











BASKETRY

middle, is started around the vertical group (a), and under the horizontal group. The rear weaver is brought over the same horizontal group.

The whole group of spokes revolves in the hand from right to left, until the horizontal group becomes the upper vertical group. The weaving is continued first with one weaver and then the other, always allowing one to pass under the group, and the other over, as shown in (b). After going around several times in this way, begin to separate the spokes into pairs, weaving first with one weaver and then with the other. After the spokes are spread apart, as at (c), single spoke weaving may be commenced by weaving first with one weaver and then with the other, as in (d). Single weaving may now be started by weaving once around with one weaver, until coming to the other weaver. The other weaver is then woven around until it comes to the same position as the first. In this way, first one and then the other, each as a single weaver, is used until the mat, or bottom of the basket, is finished.

To make a mat, decide first upon the size. Cut the spokes equal in length to the diameter of the mat, plus the length required to give any one of the above named finishes. To make a basket, decide first upon the size of the bottom and depth of the basket. Cut spokes equal in length to the diameter of the basket, plus the depth of the basket, plus the length required to give the desired finish.

Fig. XXIII (b) shows a mat of Indian weave and open border; (c) shows an Indian weave with a band of color; (d) shows a mat with triple weave, two strands of natural reed and one of color, with an odd number of spokes; observe the close finish; (e) shows the triple weave, with a band of color in single weave.

6. Baskets. If a basket is to be made, the spokes are turned upward after a thorough soaking, as shown in Fig. XXVI. In weaving the first time around, the stakes do not stand erect, as shown in (a). After weaving around several times, the stakes take a more erect position (b).

The spokes, which now become stakes, are turned so that the weaving may be continued from left to right.

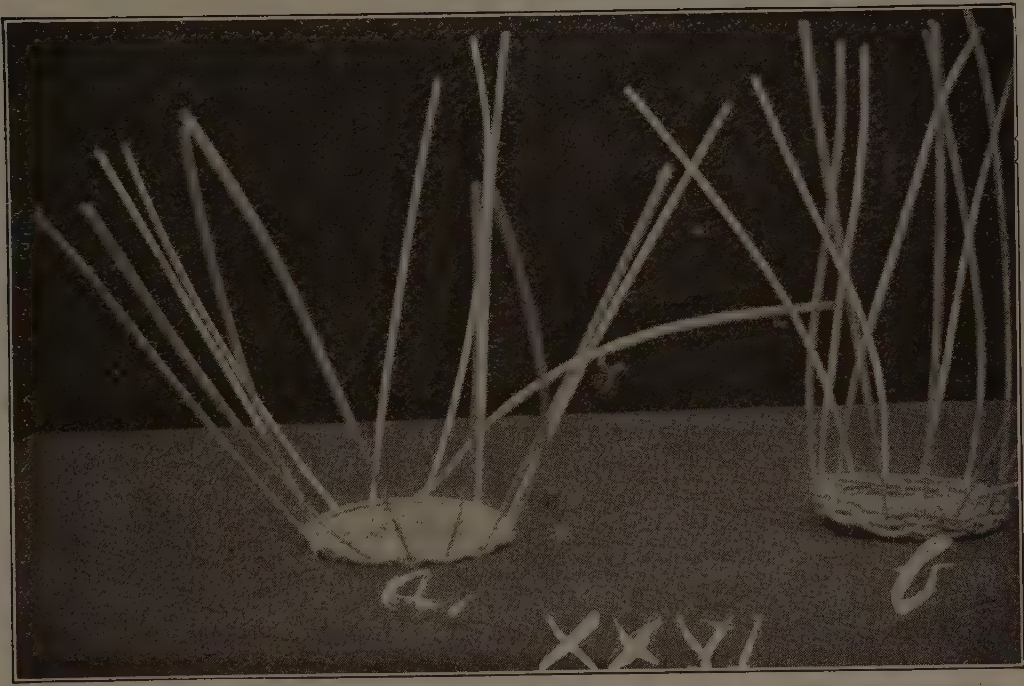
Fig. XX shows the various ways in which the upper edge of a basket or mat may be finished, after being overcast. The weaving of this close finish is started on the side nearest to you, and continued from left to right, as shown in Fig. XXVII. The starting spoke is pushed behind the one to the right and out; No. 2 is pushed behind No. 3 and out, and so on around the top, the last spoke going behind the first, and out of the loop left by it in going behind No. 2. Pull all ends tightly, as shown in the left-hand part of Fig. XXVII. For the second row, start with any spoke, put it in front of the next to the right, and through the loop, into the inside of the basket, as shown in the right-hand view in Fig. XXVII. The ends are cut off just inside of the border and close to it.

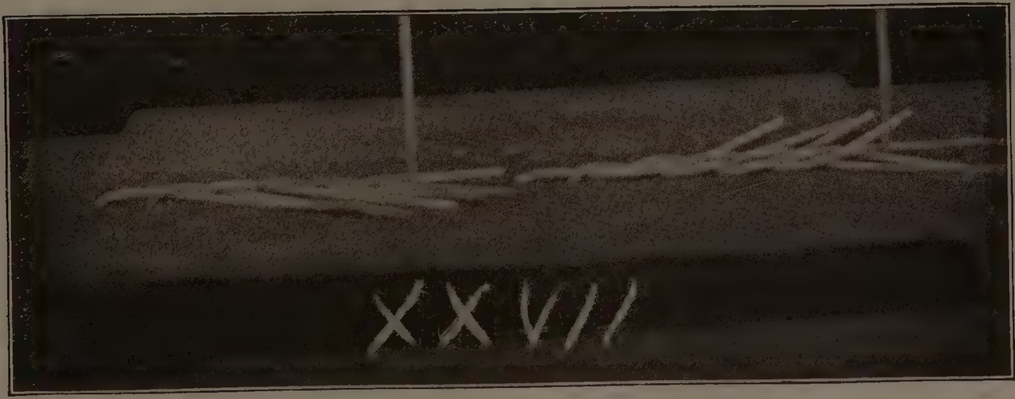
Another way to finish the top is to allow each spoke to go to the right, behind two, and out. In the next row, in front of two and through to the inside. A third way is to allow each spoke to go behind one and out, and then in front of two to the inside.

The way to begin a sixteen-spoke center is to let four pieces cross four pieces, and two rows of pairing are woven around the groups of fours before starting in twos. Weave around twos twice, and then separate into single spokes. The way to begin a center having twenty spokes is to let five cross five. Three rows of pairings are woven around the groups of fives. Each group of five is divided into twos and one, making eight pairs and four single spokes. These are woven around twice and then separated into singles.

EXERCISES IN KNOTTING

7. Twine Holder. Select eighteen long, smooth strands of raffia. Place the ends of one strand together, thus making a loop at the center. Hold a pencil, or round stick, horizontally in the left hand; bring the loop over the top of the pencil from the back, and pass the two ends up through





BASKETRY

the loop, pulling them down until the loop is held close to the pencil. (Fig. I.) In this manner loop the remaining strands on to the pencil. The knotting is done working from left to right. Leaving one strand on the left edge, knot the second and third strands. Hold the two strands together. Bring the two ends up and around to the back, across the back of the two strands and through the loop to the front. Pull the ends down into place, leaving the knot one-half inch from the pencil. Continue in this manner, knotting the fourth and fifth, the sixth and seventh. One strand will be left on the right side, corresponding to the one on the left side. In knotting the second row, two strands are left on each side. Tie until the knots assume a V shape (b).

The pencil is now slipped out, and a braid of raffia is run through the loops. This finishes the top of the twine holder. The first two loose strands at the top are knotted together; then the two pairs which follow, and so on until the loose strands are all knotted. Gather up the bottom of the holder, tying it with a strand of raffia. Cut the ends of the strands a uniform length. (c) shows the finished twine holder.

8. Shopping Bag. Draw and cut from light weight straw board an oblong 10 inches by 8 inches. On each 8-inch edge, close to the upper 10-inch edge, cut notches. Use two braids of raffia for draw strings. Place one braid around the oblong, tying in the left-hand notch; place the other braid around the oblong, tying in the right-hand notch. On each side of the oblong, and over both braids, loop 20 strands of raffia, as directed in the exercise for the twine holder. We will handle these strands of raffia in pairs (see Fig. II). The two outer strands will be knotted around the two inner strands. Hold the two inner strands in the left hand (Fig. III, a); place the right hand strand over the two inner strands (b); bring the left hand strand down over the part of the right hand strand which lies on the left of the two inner strands (c). Now the left hand strand is passed along to the right, under the two inner strands, and up through the loop formed by the right hand strand (d). Pull the right and left ends outward. This completes the first half of the knot (e). To begin another knot, the left hand strand is placed across the two inner strands, as in (f). The right hand strand is brought down over the part of the left hand strand which lies to the right of the two inner strands (g). Now the right hand strand is passed under the two inner strands, and up through the loop formed by the left hand strand (h). Pull the ends outward, one to the left, one to the right, and you will have a finished flat knot (Fig. II), called *Solomon's Knot.* Continue in this manner, handling the next two pairs, and so on, until the first row of knots, going across both sides of the oblong, is completed. In the second row the right hand strand of one knot, and the left hand strand of the next knot, are

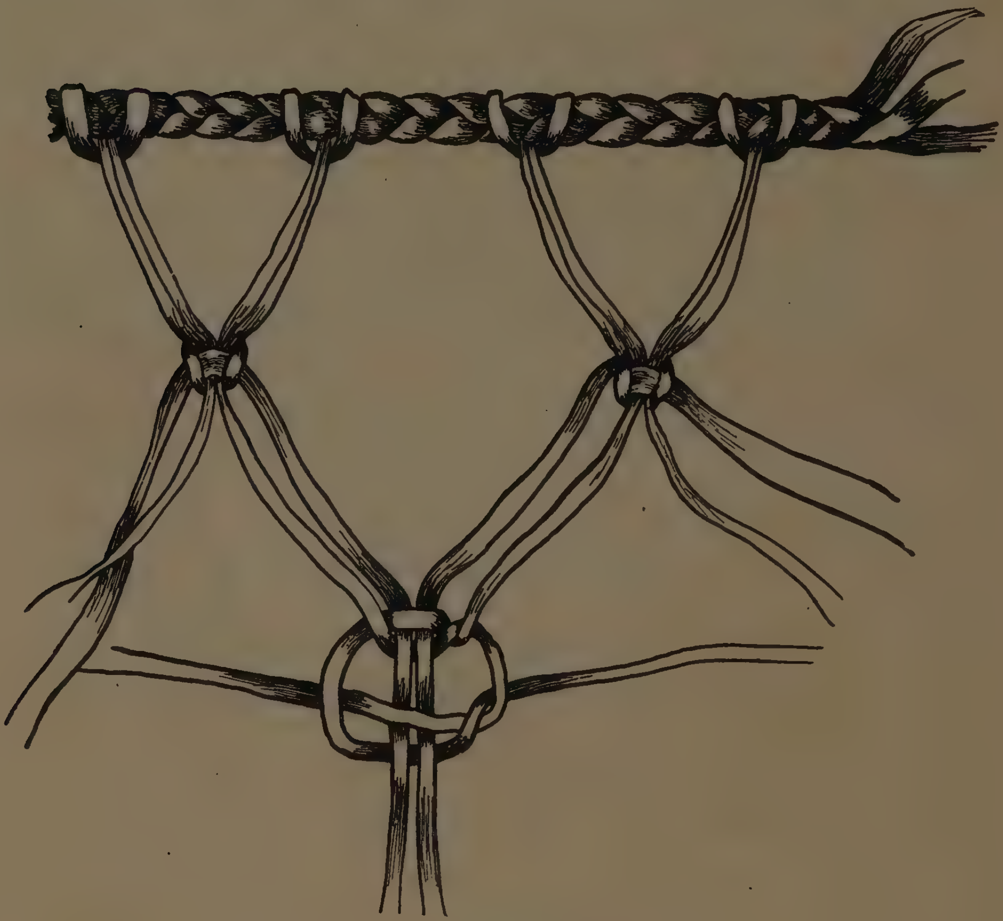
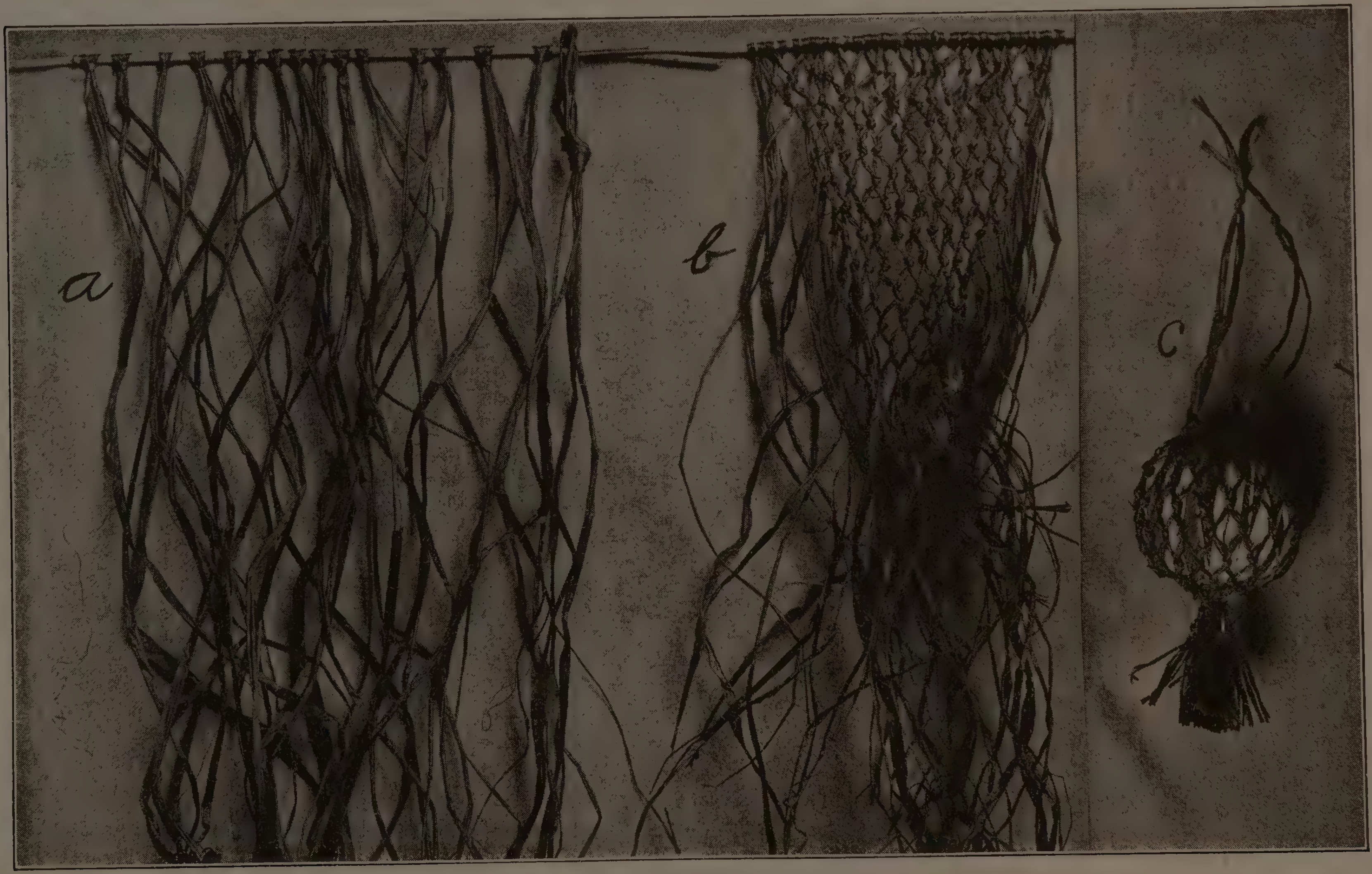


FIG. II. SOLOMON'S KNOT



RAFFIA WEAVING. Figure 1

held together, and the knot is tied with the two strands on either side of them (Fig. II).

Care must be taken to keep the meshes even. When the bottom of the oblong is reached, the two sides are joined at the bottom by placing the meshes and knots evenly together, and tying together a knot from the front and a knot from the back, with two of their outside strands. Cut the ends of the raffia a uniform length to make a good

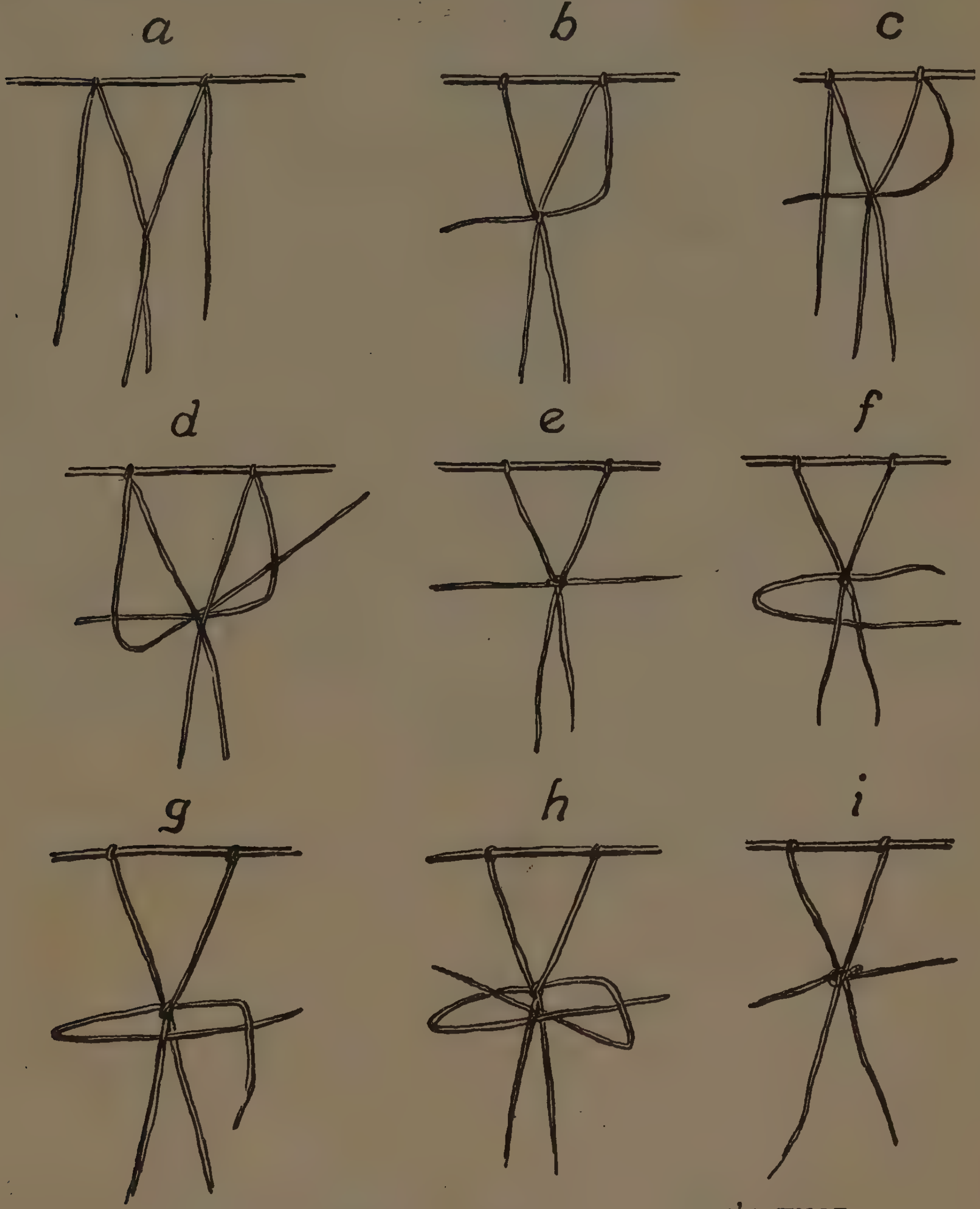


FIG. III. METHOD OF TYING A SOLOMON'S KNOT

finish. A pretty twine holder may be made in this manner by splitting the strands of raffia and making smaller meshes.

9. Knotted Work Bags. Secure a small brass ring. Into it loop eight long, red strands of raffia, as described in Section 7; or, loop seven strands on one, as shown in Fig. IV (a), and tie the ends of the foundation so as to form a ring in the center. The tied ends are dropped, making the eighth pair (b). We will call those strands *leaders*. The knot in this bag is tied as described in Section 8. On every two red leaders knot six strands of natural colored raffia in the following way: Place a strand under the two leaders, at right angles to them. Then proceed to tie the knot (Solomon's knot). Every knot must be pressed close to the brass ring, thus forming a symmetrical center for the bottom of the bag (See Fig. V). Between every two pairs of leaders we have twelve strands of natural colored raffia—six strands pointing to the left and six strands pointing to the right. Gather the twelve strands into one hand and tie together, using the first leader to the right and the first leader to the left for tying the Solomon knot (Fig. V). Treat the other leaders in this manner (Fig. IV, c).

The next step is an important one, for upon it depend the shaping of the bag. The two leaders, between two knots, naturally lie toward each other. They are tied together in an ordinary hard knot. To make the bottom of the bag flat, the leaders are tied so as to allow the work to lie flat. To make the bottom rounded, and later to draw the sides into shape, the leaders are drawn closer together. Tie all the leaders in this manner. Now the first half of the figure is finished (Fig. V, a).

Hold the leader which points to the right, in the right hand, over the bunch of strands. Take six strands from the knot on the right, and in their order, tie them in a hard knot, on to the leader held in the right hand, letting each strand come under the leader (d) (c). Take the other leader, which points to the left, and hold it in the left hand. Take six strands from the knot on the left, and in their order tie them in hard knots, on to the leader held in the left hand (c) (d). Tie once around in this manner. The two leaders

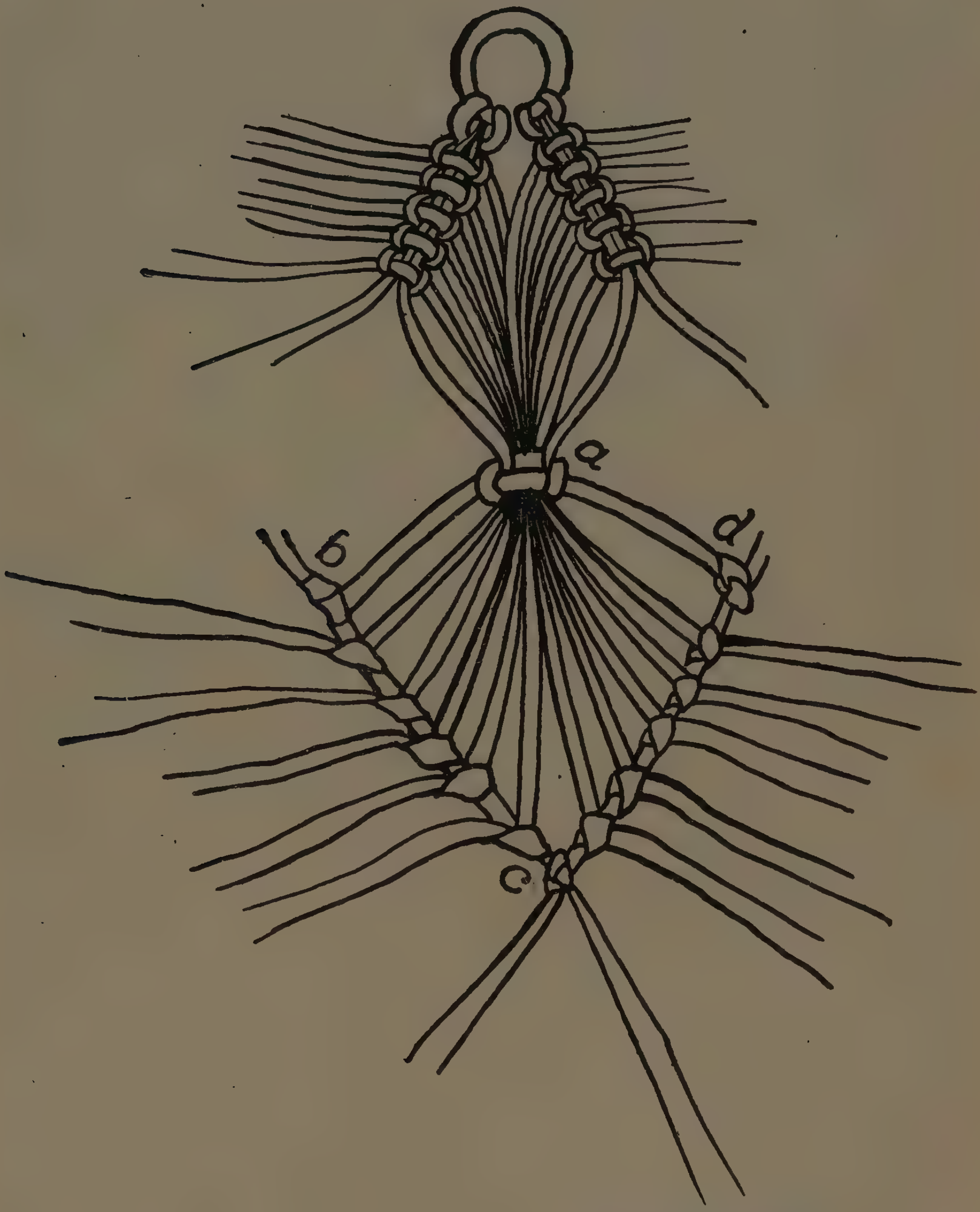


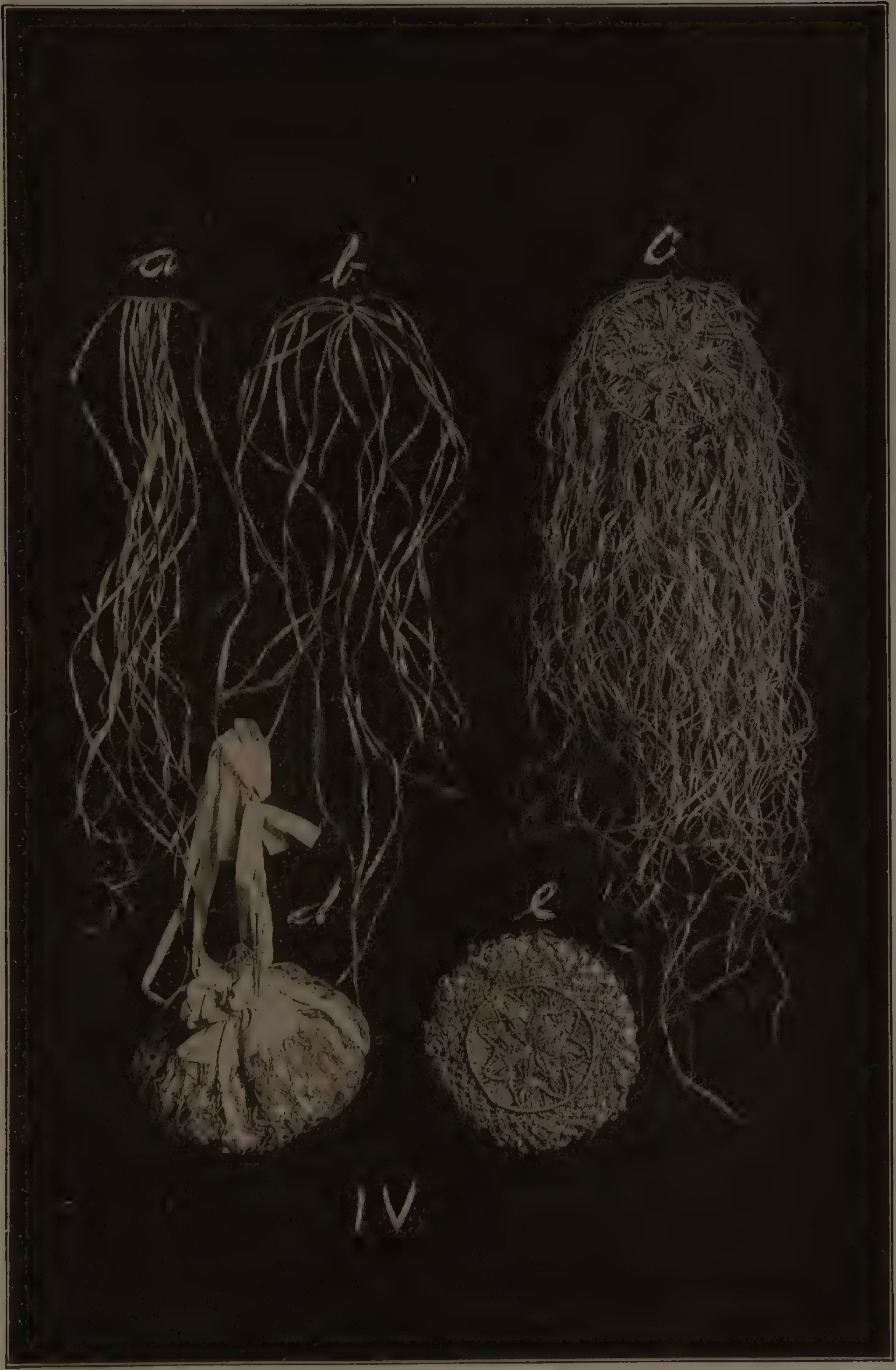
FIG. V. KNOTTED DESIGN FOR SEWING BAG

fall together at the bottom of this figure (c). The figure is now complete. Repeat the exercise until the desired shape and size are attained.

The bag may be finished in several ways: (1) The ends of the raffia may be braided and looped over to the inside, where they are fastened. (2) The ends along the edges of each scallop may be run each way from the upper point, passing through all the knots, and being cut off at the lower point of the scallop. (3) The ends may be run each way, through all the knots, to the upper point of the scallop, and tied in a small tassel (4). The edge, if finished without the tassel, may be bound by sewing over and over with narrow ribbon or raffia. Use a braided handle. A pretty lining adds to the beauty of the bag.

10. Handkerchief or Work Bag. Fig. IV (c) shows the bottom of a very attractive handkerchief or work bag. The exercise is begun as in (a) and (b). After the first row of points is completed, the ends are all tied to a piece of No. 3 reed, bent circular, as shown in Fig. IV (c). This is done by first tying the reed to the ends of the points of the leader (c). Each strand of raffia is tied with a double knot around the reed, drawing it from below just as the strands were knotted around the leader in Fig. IV. After the strands have all been knotted around the reed, begin to make Solomon knots and continue until the bag is as large as desired. The top may be finished by making rows of Solomon knots. Bend outward and fasten, making loops around the top. Cord or ribbon is drawn through the loops to close the bag, or the lining may be allowed to form a heading and the draw strings run through it, as in Fig. IV (d). Fig. IV (e) shows the bottom of the bag. By making the knots close together near the bottom, the lower part of the bag will have a more solid appearance than the upper portion, producing a pleasing effect.

11. Continuous Coil Basket. The material required is reeds and raffia. Soak a No. 2, 3, 4 or 5 reed in hot water until pliable. Dampened raffia makes the work more even and smoother. Thread a darning needle with the large end of the raffia. Scrape the reed flat, with a knife, 1½ inches from the end. Hold the reed in the left hand, and wind the



LADY'S HANDKERCHIEF BAG

Woven from raffia

thread, carefully, around the scraped portion. Wind toward the point. Shape the covered end into a round coil and sew firmly through the center until the coil is securely fastened. See that the coil is well covered with raffia (Fig. VI). This is simply stitching over and over the one coil. Introduce a new thread by placing it along the reed, and working over it until the end is securely fastened. Thread the new strand into the middle and work the end of the old one until it is securely fastened.

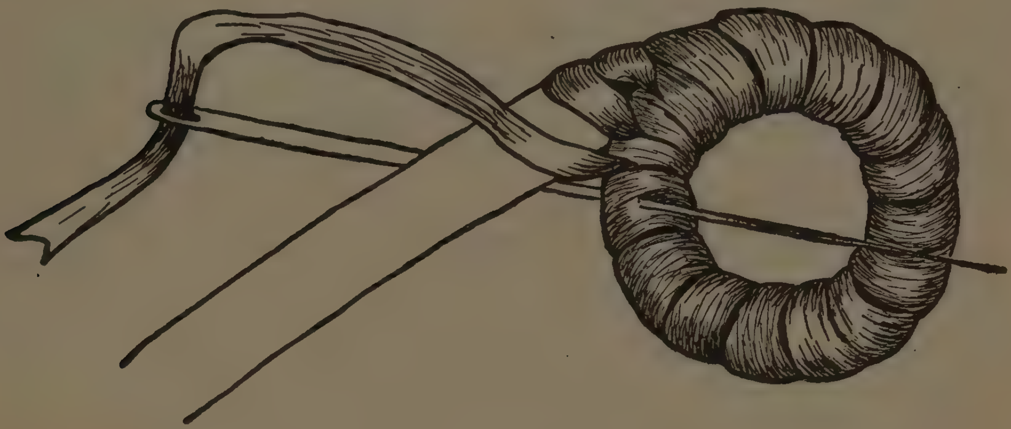


FIG. VI. COVERING A REED

To introduce color, proceed in the same manner as in introducing new threads. Do not cut the threads in changing from one color to another, but carry them along with the reed, and work over them. In filling out designs, stitches are not counted as would naturally be supposed. The design must be filled in solid, and may take more or less stitches, according to the size of the thread. A pattern of the design to be used may be cut from paper, and laid on the basket as the work progresses.

After the bottom of the basket has been made the desired size, begin shaping the side by holding the reed directly over the last coil, if straight sides are desired. If the basket is to flare, hold the reed and raffia to the outside of the last coil. If the basket is to grow smaller, hold the bunch of reeds and raffia to the inner edge of the last coil.

To splice the reed, scrape the ends to be spliced two inches from the points, and place them together, lapping one over the other, so that the size of one reed may be kept. Continue weaving, holding the ends together until they are securely fastened.

Finish the basket by scraping the reed to a point and finishing the coil off gradually. This basket may be made with a rope of raffia or an ordinary clothes line rope for the foundation.

12. Navajo Weave. (a) ROUND BASKETS. To commence a round basket, proceed as in Fig. VI. Bring the thread back between the coil and reed, and over the reed to the front, and back between the coil and reed. Bring the needle through to the front under the coil. The stitch is now complete (Fig. VIII). As the coil progresses, each stitch is passed between two stitches of the coil beneath. For introducing new threads, color, design, splicing the reed and finishing, see Fig. VI. Fig. VII (d) shows the finished basket.

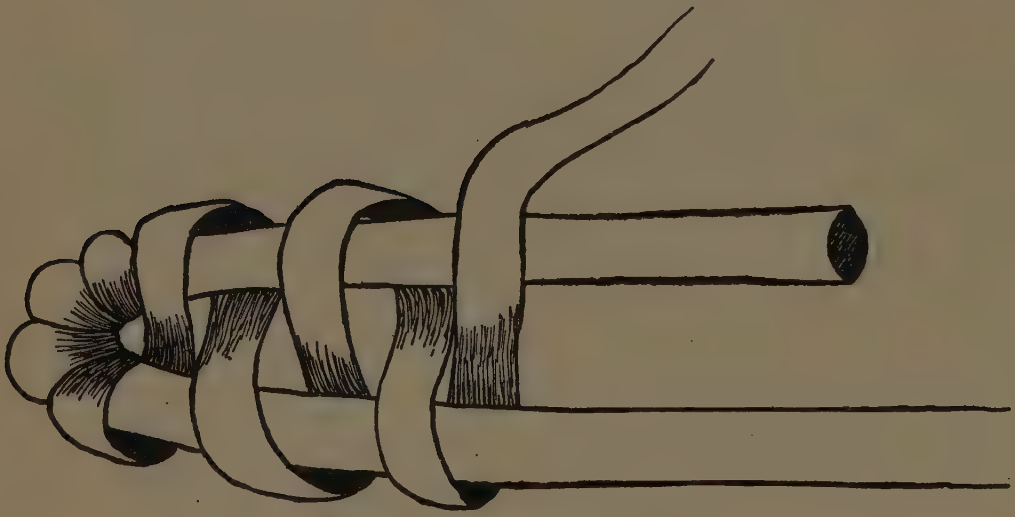


FIG. VIII. CLOSE WEAVE

(b) OVAL BASKET. To commence an oval basket, measure off six or eight inches of the reed, and carefully bend it at this point. Hold in the left hand the two reeds, keeping the short end underneath the long one, and the bent end to the right. Commence weaving by wrapping the raffia several times around the bent end. Use the Navajo stitch. Draw the thread firmly, and do not let the reeds spread apart.

(c) Needle Basket. This attractive and useful article may be made by weaving over a No. 1 reed a small Navajo basket. Make a small cushion to fit the basket. Fasten the cushion in place with threads of raffia.

13. Mariposa Weave. To commence an oval basket, follow the instructions in Fig. VI. After the bent end is smoothly covered, bring the thread over the long reed from the back down between the two reeds, around the short reed, and down between the two reeds again. Bring the thread up between the two reeds at the right of the stitch, and down between the two reeds at the left of the stitch. This completes the stitch. Both reeds (Fig. IX) are wound toward you. This is sometimes called the *open work stitch.* For introducing new threads, color, design, splicing the reed and finishing, see Fig. VI.

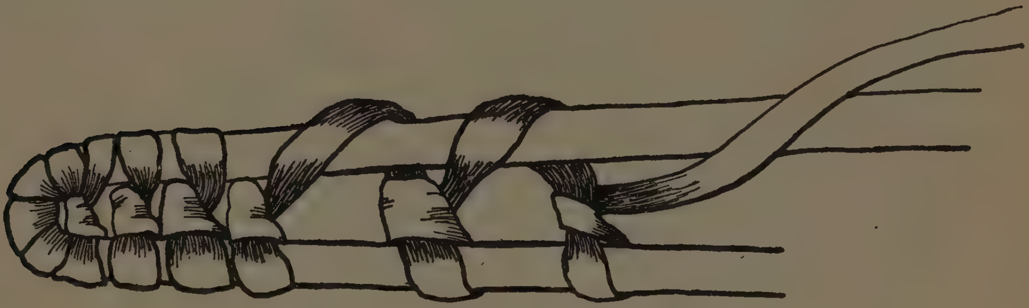


FIG. IX. MARIPOSA WEAVE

Fig. VII (b) shows the completed basket.

14. Lazy Squaw Weave. (a) Small Coil. To commence a round basket follow the instructions given in Fig. VI. This is a long and a short stitch. Hold the coil in the left hand. Wrap the raffia toward you and around the reed, then over the reed again and down through the center of the coil. This gives the long stitch, while wrapping the reed once gives the short stitch (Fig. X). In the Lazy Squaw weave the thread is wound toward you, just the opposite of the winding in the Navajo weave. For introducing new threads, color, design, splicing the reeds and finishing, see Fig. VI. Fig. VII (e) shows the finished basket.

(b) Large Coil. To commence the basket, follow the instructions given in Fig. VI, using a No. 2 reed. Gradually introduce three more No. 2 reeds and eight or ten strands of raffia. Wind the coil three or four times in making the short stitch, then down through the coil once, for the long stitch. Keep the coil a uniform size by introducing new reeds and strands of raffia. This basket is often made with coil of raffia without the reed. For introducing new threads, color, design, splicing the reeds and finishing, see Fig. VI.

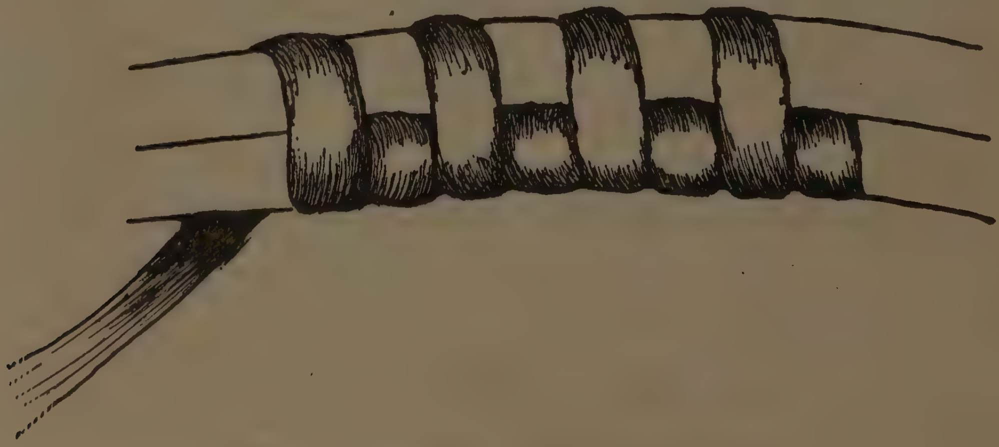
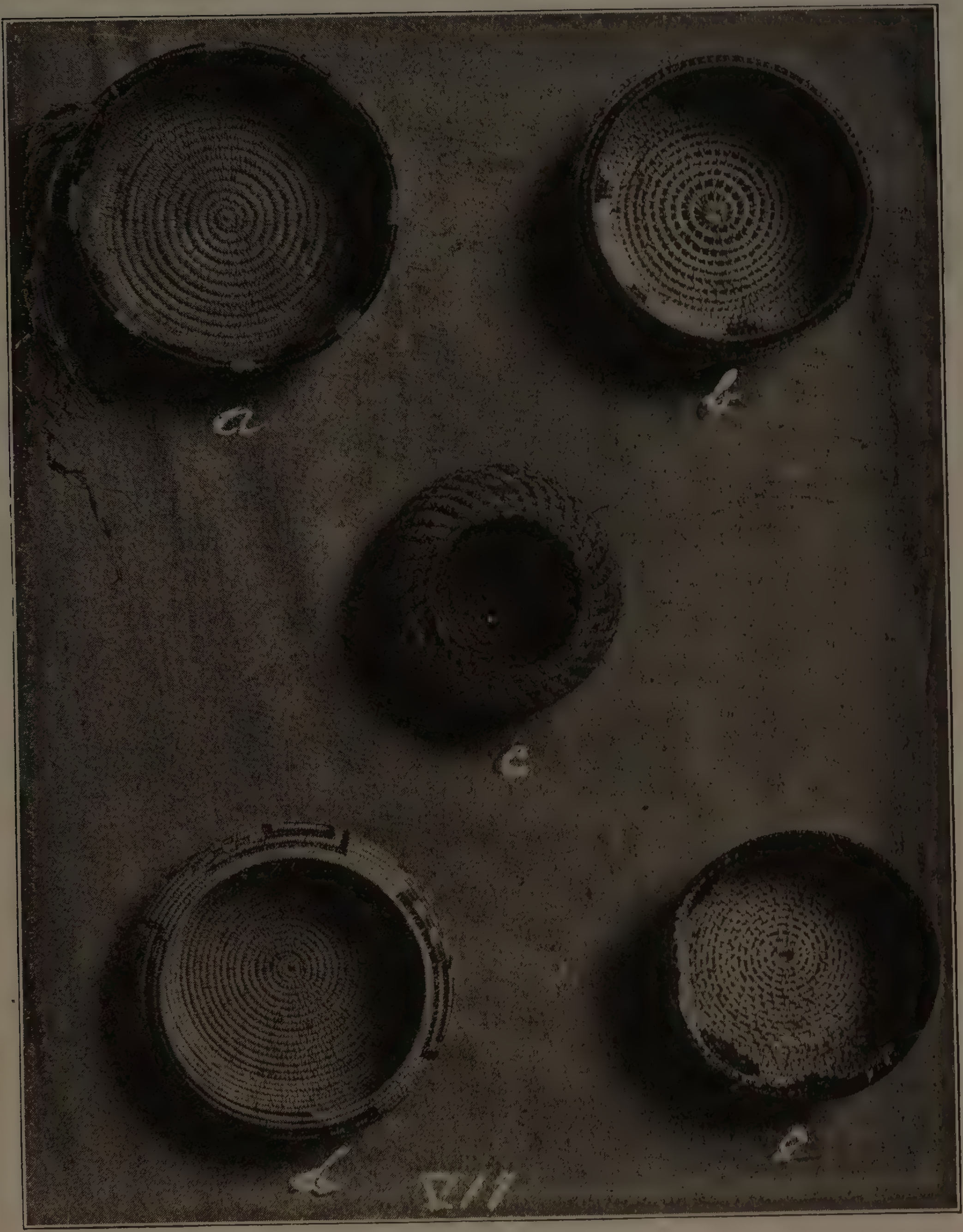


FIG. X. LONG AND SHORT STITCH

(c) Crochet Stitch. To commence this basket, follow the directions given in Section 7, using a No. 2 reed. The coil is divided into eight equal parts by the long stitch of the Lazy Squaw weave. In the second round, the long stitch falls directly upon the long stitch of the first round. Working from you, as in the Lazy Squaw weave, split the long stitch in the first coil. The ribs formed by these split stitches must radiate evenly from the center of the basket. To keep the basket firm, long stitches, forming new ribs, are introduced as the basket progresses. To introduce new threads, color, design, splicing the reed and finishing, see Fig. VI.

15. Pomo Bam Tush. Soak a No. 1 reed until pliable. Cut eight lengths. Take four of these reeds and lay them



INDIAN BASKETRY

(*a*) Continuous stitch; (*b*) Mariposa stitch; (*c* and *d*) Navaho stitch; (*e*) lazy squaw stitch.

These beautiful and useful articles can be made by any child in the intermediate and grammar grades. (*a*) Shows the loose strands of raffia of which the basket is made.

parallel to each other. With a strand of raffia, weave over and under through the centers of the reeds, until you have a square of weaving. Make two of these sets of weaving. Place the two sets together, crossing them at right angles, and having the ends of the two weavers come together. Commence weaving around the center, using both threads, one thread passing over the reed while the other passes under the same reed. After weaving around four or five times, insert two extra reeds in each corner. Now begin radiating the reeds, making a complete circle. The weaving must be firm and close. To introduce new threads, weave the new threads along with the old ones for several inches. Then push the old thread on the inside of the basket. The ends of the threads are cut off after the basket is completed.

This basket is shaped over a form—a medium sized bowl is convenient. The bottom of the basket must be woven as large as the bottom of the bowl. Place the bowl on the woven bottom, and fasten securely by tying over the top of the bowl with extra threads of raffia. The weaving may now be continued, pressing the reeds close to the bowl. Two or more colors are attractive in this weave.

When the weaving is finished, cut the ends of the spokes a uniform length, about three inches, leaving the ends sharpened. Soak in warm water until very pliable. Carefully bend the end of the first spoke and push it down beside the second spoke. Bend the end of the second spoke and push it down beside the third. Continue in this manner until all the spokes are fastened.

PAPER AND CARDBOARD.

16. Value. Paper and cardboard afford an excellent means of working out or making practical much of the number work used in the intermediate and grammar grades. Some objection is occasionally made to this material because it is not substantial. This is not a serious objection. The first exercises are simply a preparation for more advanced problems later. Every child is able to use this material because it is cheap. The paper comes in every shade of color and in various textures, and the choosing of these shades is in itself an excellent art training. Every model requires a drawing and the care and neatness necessary in this drawing afford a good means of discipline. The geometric figures require the most accurate drawing and construction. The decoration on these exercises is an important part of the problem, and forms the beginning of an art training that will be very valuable in the more advanced work in weaving, leather work, basketry and metal. This work, when properly taught, affords excellent mental training and discipline.

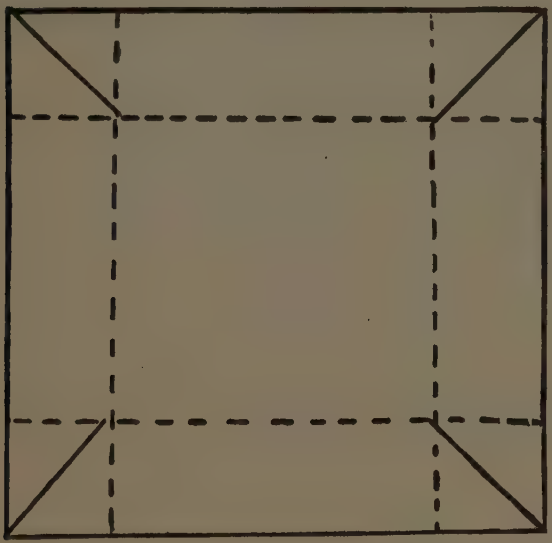


FIG. I (a) PLAN FOR CHRISTMAS BASKET

17. Baskets. The following are suggestions for Christmas, May or Easter baskets.

FIGURE I. Material: Light weight bristol board, drawing paper, or Prang special construction paper.

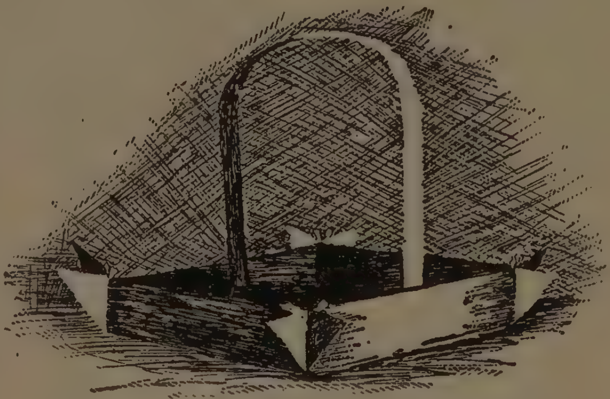


FIG. I (b) COMPLETED BASKET

Draw a 5-inch square. Draw lines one inch from and parallel to the edges of the square, as shown in the figure. Draw the diagonals of the squares found in the corners of the pattern drawing. Cut all continuous lines. Score all dotted lines. To do this, place the ruler along all lines to be creased, and draw the back edge of one of the blades of the scissors over these lines. Do not press hard enough to cut the paper. Before doing this scoring, compare your drawing with the figure to see that it is correct. Turn the triangles in the corners outward, and tie the corners with twine or narrow ribbon. Cut a handle 7 x ½ inches.

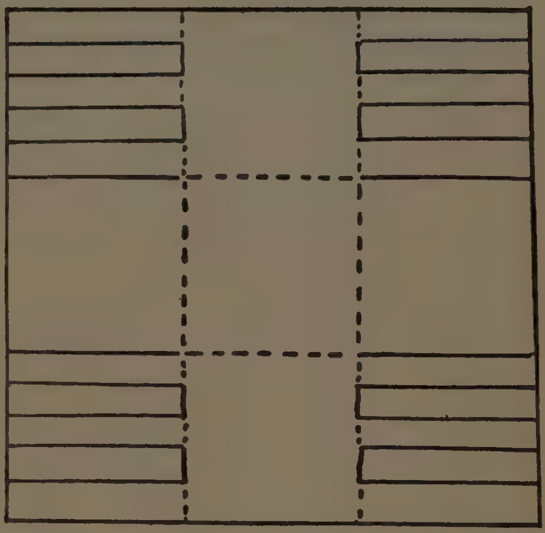


FIG. II (a) PLAN FOR EASTER BASKET

FIGURE II. Material: Drawing paper, light weight bristol board, or Prang special construction paper.

Draw a 6-inch square. Divide this into two-inch squares. Divide the squares in the corners in five parts. Study the figure before making these divisions. With young children this may be done free-hand. Cut all continuous lines, and score all dotted lines. Paste as shown in the finished basket. The center squares on the right and left sides turn upward and the strips formed by cutting the corner squares are pasted to these center squares.

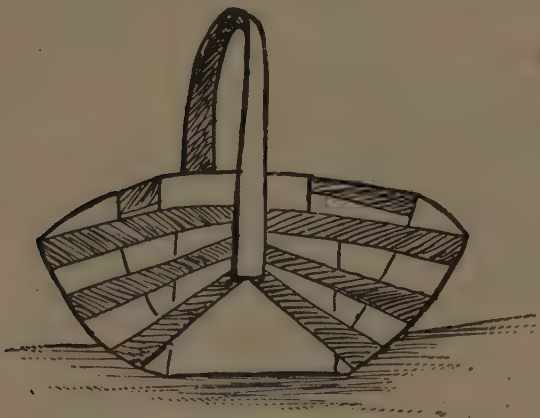


FIG. II (b) COMPLETED BASKET

FIGURE III. Material. The same material may be used as for the previous exercises.

Present a completed basket. What is the first drawing to be made in making the pattern drawing for this basket?

From the construction of previous baskets and boxes, the pupils should know that it is a rectangle. By careful questioning the teacher is often able to get the pupils to work out for themselves much that is ordinarily dictated, thus giving the pupils no opportunity to think for themselves. Draw a rectangle 5¾ by 4¼ inches. Draw other lines within this rectangle 1¼ inches from and parallel to the edges of the rectangle. There is now a 1¼ inch square in each corner.

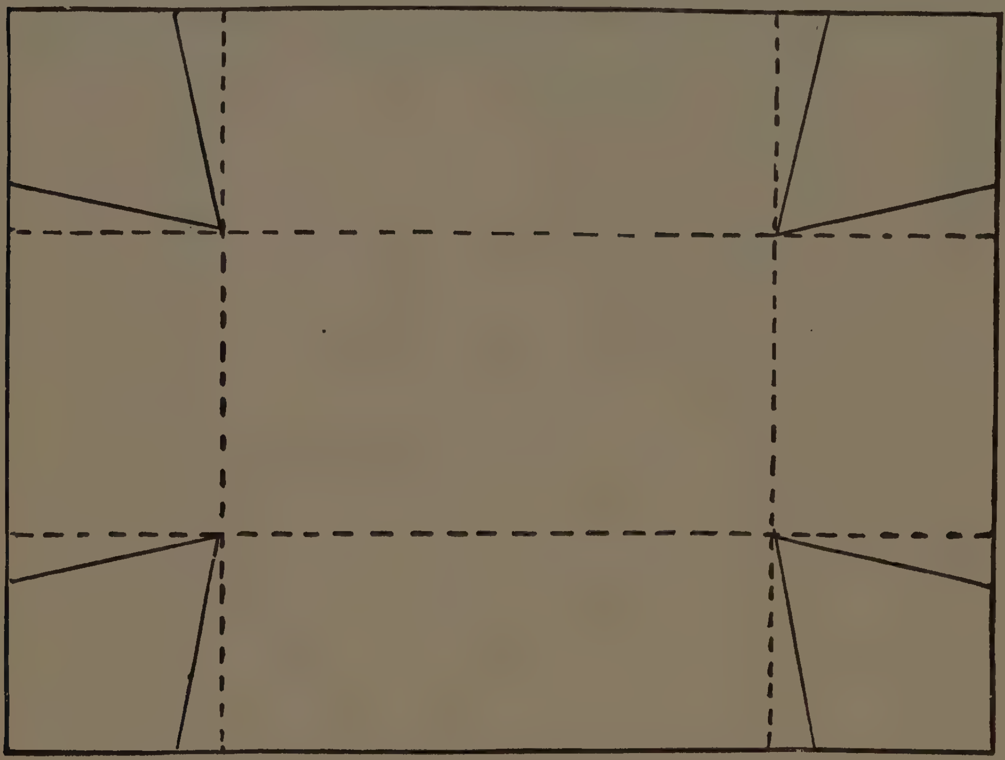


FIG. III (a) PLAN FOR FLOWER BASKET

The slanting straight lines within these small squares are ¼ inch from the outside corners. Study the figure. Cut all continuous lines and score dotted lines, which form the bottom of the basket.

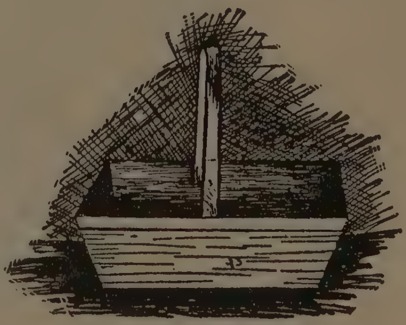


FIG. III (b) COMPLETED BASKET

Cut a strip 12 inches long and ¼ inch wide. This strip is pasted around the top to hold the upper edge of the basket together. Before beginning to paste the strip, mark it off into four parts, as this will tell exactly the part of the strip which is to be used along each edge. Begin to paste the strip at the middle of one side or end. By doing this, the seam will not come at a corner. Cut a handle 6 by ½ inches.

Figure IV. Material: Light weight bristol board, drawing paper, or Prang special construction paper.

Draw a 6-inch circle. (This means a circle measuring 3 inches from the center to the circumference.) Bisect the circumference of the circle vertically and horizontally by placing dots in the circumference. With each of these points as a center, draw a 2-inch circle (one inch from center to circumference). These circles cut the large one. Use these points of intersection as centers, and draw other 2-inch circles, as shown in the figure. Cut all continuous lines and fold into shape as shown in the completed basket. Tie at the corners with twine or ribbon.

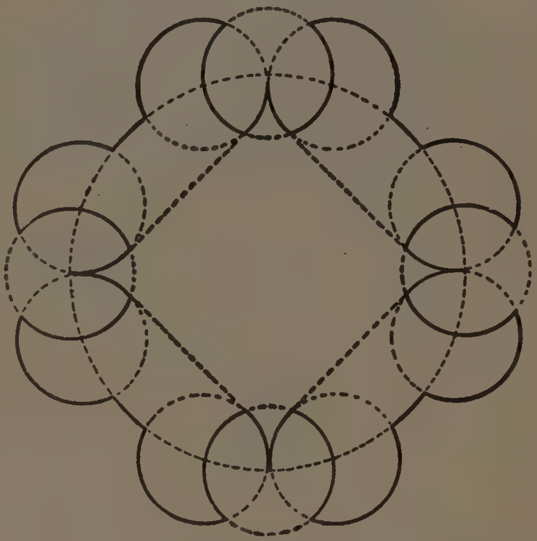


FIG. IV (a). PLAN FOR MAY BASKET

Figure V. This exercise is almost the same as Figure IV, only it is cut differently. The square drawn in the center is made by placing the ruler across the points where the middle circle bisects each of the others, or by connecting *a* and *b*, *c* and *d*, *e* and *f*, *g* and *h*. Study the figure carefully before making the drawing. Cut all continuous lines and fold into shape. See the drawing of the completed basket. Tie the corners.

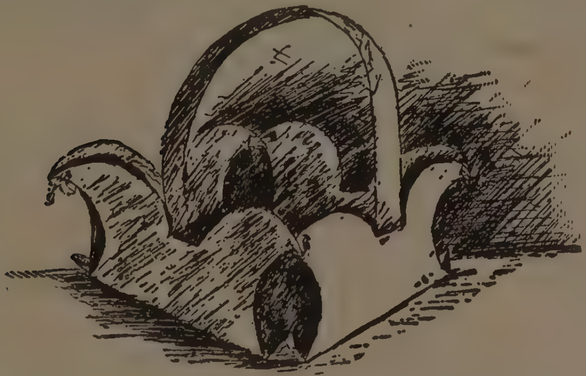


FIG. IV (b). COMPLETED BASKET

18. Boxes. Since so many uses for boxes may be found in the primary and intermediate grades, directions for making a few of the more simple ones are given. There are boxes for colored crayons, seed boxes, boxes for colored shoe-pegs and toothpicks, candy and valentine boxes.

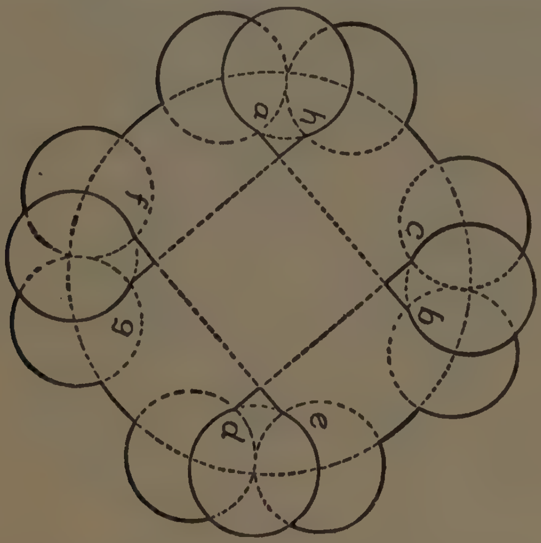


FIG. V (a) PLAN FOR MAY BASKET

SQUARE BOX. Material: The same as in the previous exercises. Figure VI shows the pattern and completed drawings for a 3-inch square box with cover attached. Draw a rectangle 9 by 5 inches. Draw lines within the rectangle 1 inch from and parallel to the edges of the rectangle. Draw parallel lines across the center, 1 inch apart, as shown in the drawing. Cut all continuous lines. Score the dotted lines. Turn the sides upward, and paste. Study the figure.

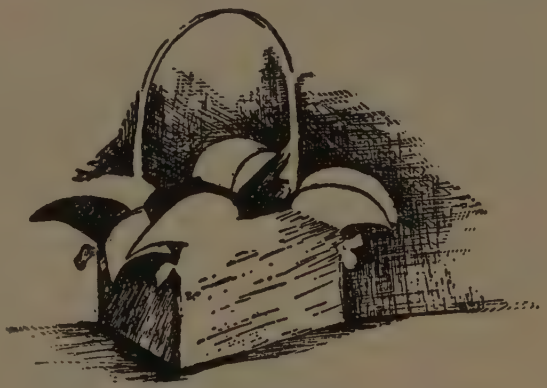


FIG. V (b) COMPLETED BASKET

RECTANGULAR BOX. Material: The same as in previous exercises. See figure VII. Draw a rectangle 9 by 7 inches. Draw lines parallel to and 1 inch from the edges of the rectangle. Draw parallel lines through the center, 1 inch apart, as in Fig. VI. Cut all continuous lines. Score all dotted lines. Turn upward and paste.

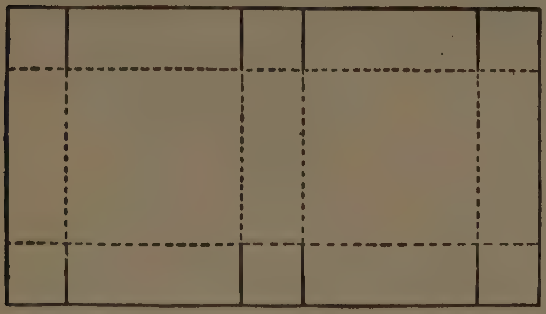


FIG. VI (a) PLAN FOR SQUARE BOX

TRIANGULAR BOX. Figure VIII. Material: The same as in the previous exercise. Draw a 7-inch square. Draw lines 1 inch from and parallel to the edges of the square. Draw straight lines ¾ inch from the edges of the small squares in front, left and back, right corners, as shown in the figure. Connect with the ruler the points where the lines just drawn touch the inner lines, and draw diagonal lines as shown in the pattern. Cut all continuous lines. Score all dotted lines; fold and paste.

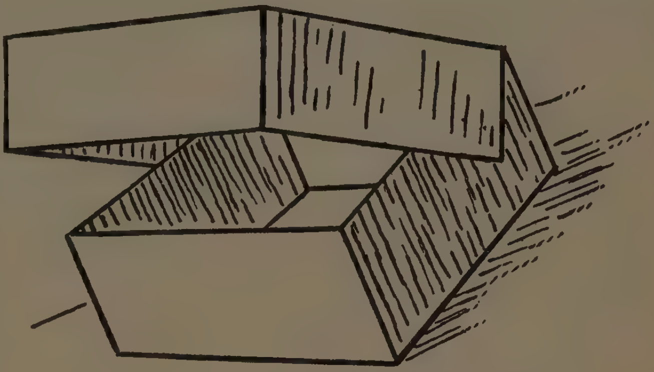


FIG. VI (b) COMPLETED BOX

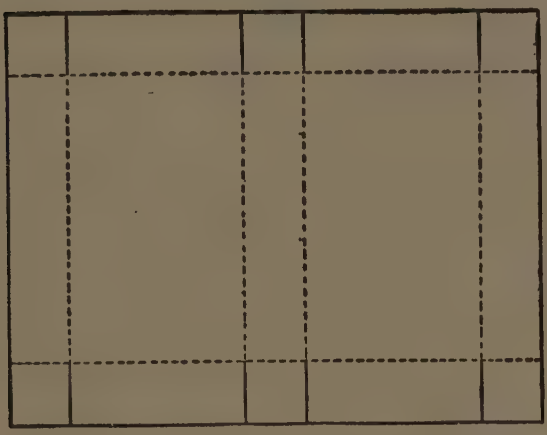


FIG. VII (a) PLAN FOR RECTANGULAR BOX

Hexagonal Box. Figure IX shows a pattern drawing for a hexagonal box, with cover attached. Draw a 3-inch circle within a 5-inch circle, using the same center. With 1½ inches on the circle maker, mark off six points in the circumference of the small circle. Connect these points with straight lines. From each point draw a straight line perpendicular to the edges of the hexagon. With *a* and *b* as centers, and a distance equal to *ab* on the circle maker, draw two arcs which intersect at *c*. With *c* as a center, draw two other circles the same size as the ones just drawn. Proceed to construct the cover on the same plan as the box. When cut and pasted, the result is a hexagonal box with cover attached.

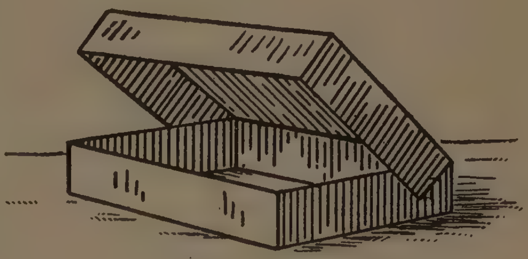


FIG. VII (b) COMPLETED BOX

19. Envelope Folio. Material: Heavy cover paper. Draw a rectangle 17¾ x 11½ inches. Place the long edge of the rectangle parallel with the front edge of the desk. Draw a line parallel to and 5 inches from the left edge of the rectangle. Draw a line parallel to and 4¼ inches from the right edge. Draw other lines parallel to and 2 inches from front and back edges. Draw slanting lines as shown in the pattern, Fig. X, from points on outside edges. 1 inch from corners, to inside corners. Draw a tongue, as shown, at right. On the opposite side cut slits into which the tongue may be drawn. This makes a very interesting folio, in which language papers or drawings may be kept.

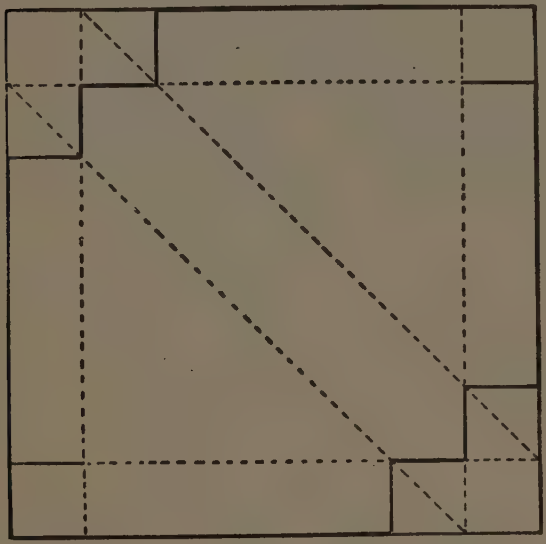


FIG. VIII (a) PLAN FOR TRIANGULAR BOX

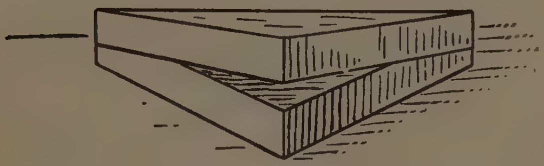


FIG. VIII (b) COMPLETED BOX

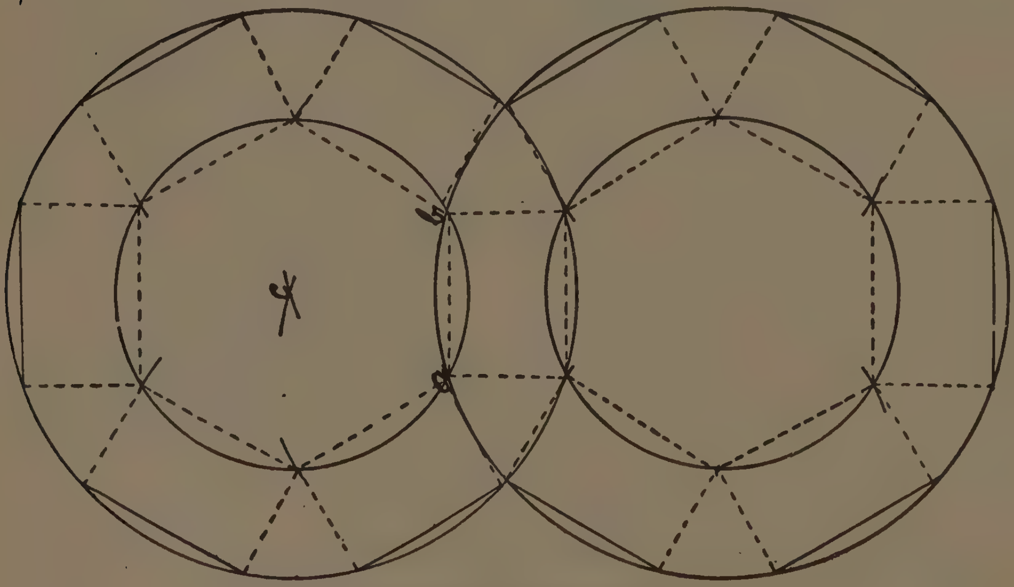


FIG. IX. PLAN FOR HEXAGONAL BOX

20. Lantern. Figures XI and XII show drawings for a lantern. Material: Jute or straw board.

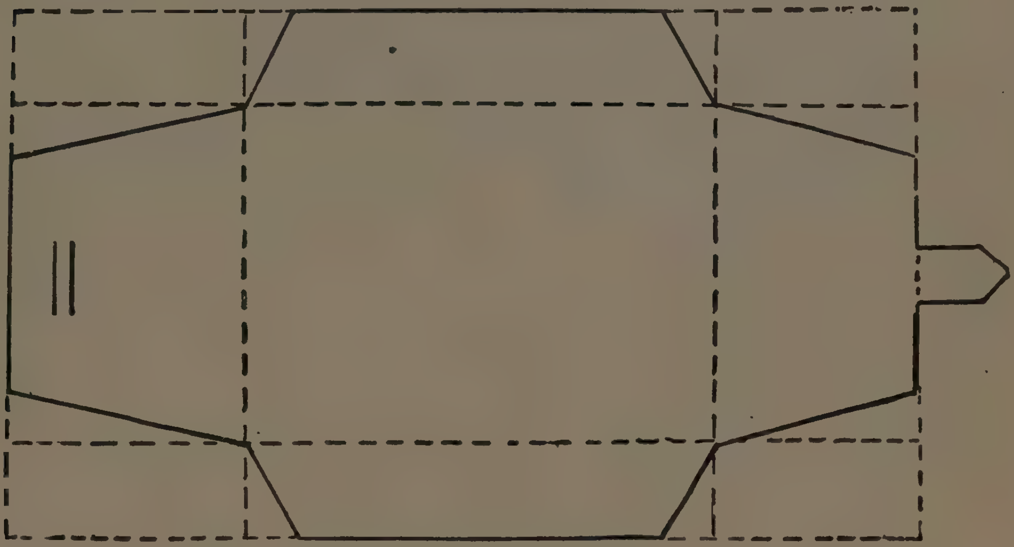


FIG. X. ENVELOPE

Draw a rectangle 6 x 5 inches Place the short edge parallel with the front edge of the desk. Draw slanting lines from points 1 inch from the front corners to the back corners, as shown in Fig. XI. Bisect the back edge, and $2\frac{3}{4}$ inches from this point of bisection place a dot at the point marked "a". Connect the back corners by slanting lines to this point.

Bisect the front edge of the rectangle and place a point at "b", $1\frac{1}{2}$ inches from the point of bisection. Connect "b" with slanting lines drawn within the rectangle.

We now have a pattern for one side of the lantern. This when placed or repeated, as shown in Fig. XII, gives the complete drawing for the lantern.

By use of the shoemaker's punch, holes are placed as shown in the draw-

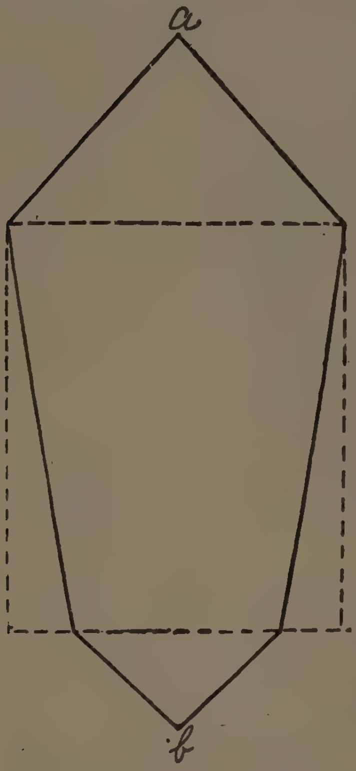


FIG. XI. DRAWING FOR LANTERN

ing. Lace back and forth with a colored twine, and we have the finished electric lantern, as shown in Fig. XIII.

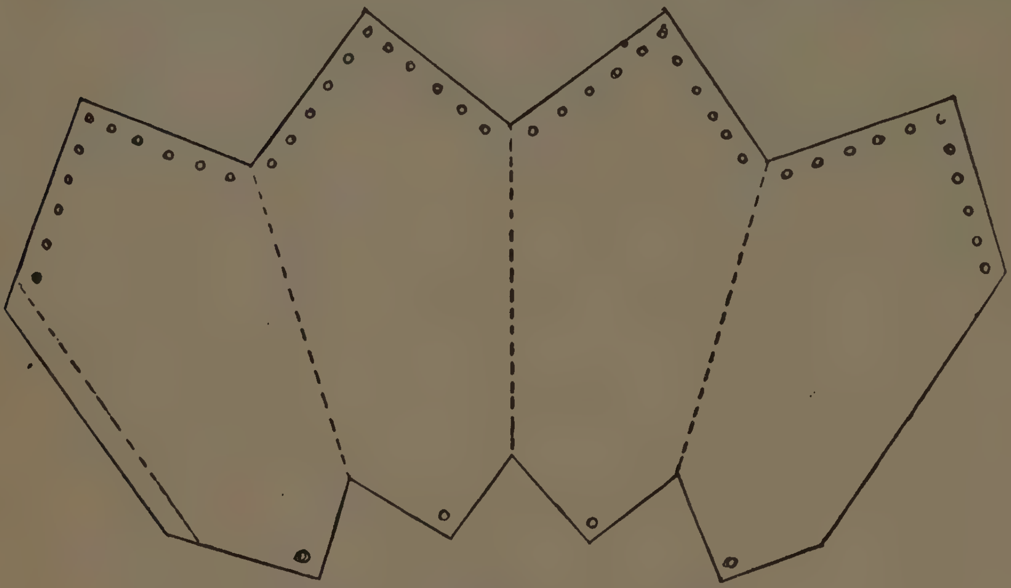


FIG. XII. PATTERN FOR LANTERN

A design is cut in each side and colored tissue paper is placed on the inside. Fig. XIII shows the design.

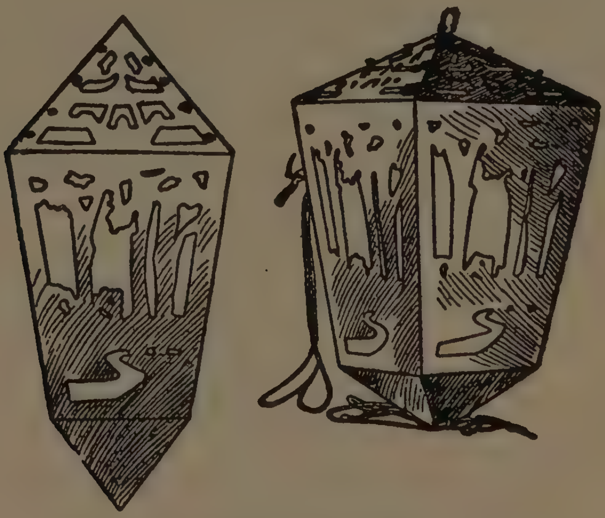


FIG. XIII. COMPLETED LANTERN

DYE STUFFS

21. Vegetable Dyes. (a) INDIAN DYES. When we come to the coloring of baskets or the materials of which they are made, we enter another field that has been only partially explored. We must form our tastes from good models, and nothing better is known to art than the olden hues used in baskets made by the Indian tribes of the Southwest.

A visit to any museum where there is a collection of these Indian baskets will enable one to recognize the soft, rich, quiet Indian colors.

True Indian colors, used in basketry are few in number, red, green, black, cream, yellow, brown and occasionally blue; but there are many soft gradations of self-coloring—soft yellows, browns, greens, that are more harmonious than brighter colorings would be.

It is true that the "Indian dyes may be duller, that they do not run through such a lengthy, diverse and brilliant chromatic gamut as the white man's dyes, but the Indian dyes are permanent and they are so softened by the mellowing touch of time, as to gain with age an exquisite combination of color values, altogether inimitable."

Vegetable dyeing is a fascinating part of basketry. When one is interested he is led to make many new discoveries.

It is surprising how many beautiful dyes may be found in the fruits and blossoms of many plants.

The faded flowers of the purple iris are full of the purple liquid.

The Indian method of dyeing is as different from ours as is their choice of materials.

Sometimes they bury spruce root and other woody fibres in certain mineral springs or mud pools for weeks and months, and thus gain a beautiful chocolate color. In another tribe a pit is made, the material is smeared with charcoal paste, sprinkled with two inches of willow ashes, and the whole covered with loose, damp earth, and allowed to remain three or four days. Experience has taught the Indian that if it is left too long, the lye will eat the fibre and render it useless, and if taken out too soon the color will be brown instead of the desired glossy black.

Squaw grass, used by the Klickitas in their exquisite basketry, is naturally white, but is turned to yellow by being soaked a certain length of time in cold water, while a rich brown is obtained by using hot water.

Boiling mud from sulphur springs that abound on some of the reservations is used to color splints black.

Some berries are used for red, and the seed-case of the sunflower yields a dark rich purple.

These Indian methods of dyeing are crude and laborious, but the results are exquisitely beautiful and fadeless. So long as we seek by means of vegetable and mineral dyes rich, soft and enduring hues, it is perfectly legitimate to shorten and simplify the process and to employ any labor-saving device.

(b) RECIPES FOR DYEING RAFFIA AND RATTAN. (1) *Mordant.* A useful mordant for most vegetable dyes is made from three ounces of alum dissolved in one quart of water. Soak the raffia, rattan or grass, etc., in the mordant over night and drain before putting the material into the dye proper. All material must be thoroughly cleaned before dyeing.

(2) *Blue.* Indigo is a pure and enduring dark blue, but demands so much attention and labor that it is not a favorite with amateur dyers. An indigo dye-pot, once started, may be used almost indefinitely by adding more dye as the old is used.

Take eight parts of indigo (paste), three and one-half parts of bran, and twelve parts of potash or lye, with sufficient water. Keep this solution at about 95 degrees for a week to ferment. If it is slippery it needs more bran and lye. Use the latter, one part saturated solution to nine parts of water. This bath will have a greenish color, not at all like indigo.

The material to be dyed is placed in the warm dye, allowed to remain from one to several hours, according to its absorbent capacity, is then hung in the air, in a breeze if possible, is again put into the dye and the process repeated until desired shade of dark blue is obtained.

No alum or mordant is used with indigo. Get the indigo paste at some dye house.

(3) *Yellow.* (a) Soak raffia or rattan in alum mordant over night.

Soak fustic chips over night; in the morning boil for ten or fifteen minutes in the same water. Strain. Place the material in the strained solution, letting it remain until the desired shade is obtained. If the chips are boiled too long a dull olive color is obtained. It is for this reason the chips are removed after boiling ten or fifteen minutes.

(b) Make a solution with green peach leaves. No mordant is used.

(c) Make a solution with bark from the white oak tree. No mordant is used.

(d) A common weed, in temperate climes growing in fence corners, and much abhorred by farmers for its disastrous effects upon stock when it gets mingled with hay, is the sneeze-weed. This, as well as many yellow composite blossoms, will give a pure fadeless yellow, when made into a strong tea. Use an alum mordant.

(4) *Scarlet.* Mordant the material with six parts of stannous chloride crystals to four parts of cream of tartar. Dye with cochineal which has been boiled and strained, until the desired color is obtained.

(5) *Red Orange.* Cochineal added to the fustic solution for yellow gives a dull red orange.

(6) *Orange from Annatto.* A bright orange is made from annatto. A short time before it is required for use it is dissolved by boiling

it with a solution of carbonate of soda (washing soda) for twenty minutes. Mordant the material with stannous chloride (or tin crystals), which dissolve in a small quantity of water, and dye.

A bright red orange is obtained by using broom sedge dye first. Drain and dry, then color with madder root.

(7) *Red.* Wash the material and soak in an alum mordant over night. Make a solution with hypernic chips. Boil for ten or fifteen minutes the following morning and strain. Place the material to be dyed in the strained solution, leaving it until the desired shade is obtained.

(8) *Indian Red.* A fine Indian red may be obtained by using extract of sumac.

Use an alum mordant.

(9) *Black.* A good black may be obtained by boiling logwood chips in sufficient water to cover them, for fifteen or twenty minutes. Add sufficient water to cover the material to be dyed. After boiling fifteen minutes, drop in a few lumps of copperas. When the desired black is obtained remove the material.

Sometimes the raffia is soaked in a solution composed of fifty parts of logwood and ten parts of fustic for one-half hour. The raffia is then removed and four parts of copperas added. The material is again returned and allowed to remain for fifteen minutes. This gives a good black.

(10) *Purple.* Soak the material in an alum mordant. Place in an extract of logwood, which is obtained by boiling the chips.

If a bluer purple is desired, add a little ammonia, baking soda or baking powder.

(11) *Green.* To color green use three parts of yellow and eight parts of blue.

Experience will show the worker that many gradations of color may be obtained by allowing the material to remain a longer or shorter time in the dye-bath.

Different shades of green may be obtained by changing the proportions above mentioned.

(12) *Brown.* The shucks of the butternut are used in dyeing a beautiful shade of brown.

Soak the shucks several days and then boil them for about twenty minutes. Strain, add sufficient water to cover the material. Remove the material when the desired shade is obtained. No mordant is necessary.

(13) *Brown from Walnut.* Treat the shucks of the walnut the same as those of the butternut.

A very good brown may be obtained from the bark of the walnut root. No mordant is necessary.

(14) *Brown from Logwood.* Cover the logwood chips with water

and boil ten or fifteen minutes. Strain, add sufficient water to cover material and boil for another twenty minutes. No mordant is necessary.

(15) *Brown from Hypernic.* A seal brown may be obtained from the chips of hypernic, the process being the same as in the use of the logwood. No mordant is necessary.

(16) *Olive.* To obtain a soft olive, dye first with the brown sedge, wash, drain, and then dye in indigo until the desired shade is obtained. Use an alum mordant.

Another olive may be obtained by mixing a pale purple with green.

(17) *Red.* The bark of the red oak makes a very fine red in coloring raffia, tilo and reed. A lump of lime about the size of a base-ball, dissolved in about five gallons of water, makes a very good mordant. The material is first dipped in the lime water and then placed in the oak solution. To extract all the color from the bark, boil thoroughly for about twenty minutes before placing the material to be dyed in the solution.

(18) *Yellow.* A very good yellow may be had from the blossoms of the golden-rod.

(19) *Green.* Tomato leaves and nasturtium leaves make a good green.

(c) GENERAL SUGGESTIONS. There are many other simple recipes for dyeing, but those given will be found sufficient for the beginner. Experimenting will teach the dyer that different materials take the dye in different times; thus, raffia requires only one-half the time that must be given to rattan.

To gain a certain hue, the material must be frequently lifted with two sticks and examined. It must be turned over and over, so all parts may be evenly submerged in the dye.

All materials must be thoroughly rinsed after being removed from the dye, and slowly dried in the open air.

The soap-weed or yucca, which is so invaluable to the basket-maker of California and the Southwest, yields four distinct hues that again merge into each other, forming most exquisite transitions of color. There is the ivory white of the heart of the plant, running to the dark olive green of the outer circle of the mature leaves. The Indian woman carefully separates these colors when she strips the leaves and hangs each color bunch by itself from the rafters of her house. Yucca is frequently colored red or brown. Sometimes plants are bleached to obtain white.

In some plants the two sides of the leaf will yield different colors.

Using undyed materials, the amerind produces a black effect with the ripe, peeled pods of the martynia, a dark brown with the stems of the maiden-hair fern, and a bright red with the roots of the yucca.

The teacher of rural schools will find this problem of vegetable dyes a very interesting one.

22. Aniline Dyes. The market is full of aniline dyes of various brands. All are good, but perhaps the one most conveniently used is the brand called the Easy Dye. It comes in tubes and may be used with cold water. The Easy Dye is furnished by the School Arts Supply Company, Lockport, Illinois. A little booklet is furnished free of charge, giving full directions as to its use.

TEST QUESTIONS

1. Make five statements in favor of paper and cardboard construction.
2. Give the commercial names of three different papers or cardboards suitable for construction.
3. What is reed? Where does it come from?
4. Give the names of two Indian baskets, and make drawings to illustrate stitches used.
5. What is meant by vegetable dyes? Name five local vegetable dyes.
6. Name four imported vegetable dyes.
7. How did the Indians secure their colored materials for basketry?
8. Make a drawing to show the way a reed basket is begun.
9. In making a small reed work-basket, state the size of reed you would use. Name three different weaves.
10. What is tilo? Where does it come from?

CHAPTER SEVEN

SPELLING

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State Normal University

1. Conditions. Thousands of young people yearly go from the public schools to business positions in which they are required to make practical application of the knowledge of English which they have obtained. Unfortunately, many fall far short of the standard which they are supposed to have reached; and failure to teach the pupils to spell is one of the most common charges against the public schools.

2. Value of Spelling. Spelling is a practical, rather than a cultural, study, and when considered from a practical point of view it is found to possess commercial value. Business men will not place in responsible positions those who cannot spell correctly. Moreover, most firms are particular about their correspondence, and employers cannot afford to spend time in correcting errors in language and spelling that are made by a stenographer or a clerk. Ability to spell correctly, therefore, is essential to retaining a good position.

While emphasizing the practical value of spelling, we should not entirely overlook its cultural value. This is seen in its effect upon the individual. The person who is not sure of his spelling is never at ease when required to write even the simplest form of paper or letter, and the discovery of his errors by another is often humiliating in the extreme.

"It is no particular credit to be a good speller, **but it is a** disgrace to be a poor one." For these reasons, the importance of learning to spell should be emphasized in the intermediate and grammar grades.

3. Causes of Poor Spelling. In teaching spelling, certain difficulties are encountered, and these must be understood and conquered, if one is to succeed. Among these difficulties are the following:

(a) STRUCTURE OF THE LANGUAGE. The English language is chiefly the result of the union of two languages—the Anglo-Saxon and the Norman-French. But this result has been greatly modified by other languages and by changes due to the dialects used by the early English-speaking people in different localities. The spelling of the Anglo-Saxon and Norman-French was largely phonetic, but changes and interpolations destroyed much of this style; then, too numerous additional changes were introduced by Gutenberg, the inventor of printing, and his immediate successors, who tried to engraft Dutch spelling upon English words. Again, the alphabet does not contain enough characters to represent all the sounds in the language, so that some letters, as *a* and *e*, for instance, have several sounds. In numerous words the spelling does not indicate the pronunciation of the word, and in others the pronunciation does not indicate the spelling.

For some unknown reason, these early spellings were handed down from one generation to another until they were introduced into the first English dictionary. This gave them a permanent character, so that a large number of them, awkward and absurd as they are, have been retained to the present time. There has been, however, considerable progress in simplifying some spellings, and a large number of able scholars are still working on the problem. Because of prejudice and invested interests in dictionaries and other works of reference, the progress of these people is necessarily slow, but gradually the simplified forms are working their way into use. Regardless of this, the standard forms are those generally accepted, and are those which we are compelled to employ.

The above explanations show why there can be but few rules for spelling English words, and one who begins to learn these rules soon finds that each has numerous exceptions. Consequently, the spelling for all except phonetic words must be remembered arbitrarily.

(b) DEFECTIVE SENSE ORGANS. Primarily, spelling is a form study. The form of the word must be so firmly fixed in mind that it can be reproduced whenever required. Some children are not strongly eye-minded; that is, they do not readily grasp and retain forms. Such children become good spellers only through prolonged practice. Moreover, the eyes of many children are more or less defective, and until this defect is remedied, they do not perceive the forms clearly. Tests often show that poor spellers have defective vision. Again, children who are not eye-minded are usually strongly ear-minded; that is, they perceive words by sound rather than by sight. The spelling of such children is likely to be phonetic; as, *jerney* for *journey; thot* for *thought*, and *site* for *sight.* Defective hearing does not tend to poor spelling, because it throws greater responsibility upon the sense of sight.

While the spelling of some words is not closely related to their pronunciation, in most cases correct pronunciation assists in correct spelling. Pupils who do not understand the pronunciation of a word are more liable to misspell it than those who do. The cultivation of correct pronunciation is therefore of importance.

(c) LACK OF UNDERSTANDING. Pupils spell words much more accurately when they know their meaning and use. To ask children to learn the spelling of lists of words which are entirely strange to them leads to confusion and, often, waste of time.

(d) HASTE. In written composition, and especially in writing exercises from dictation, the thought runs ahead of the hand, and this often causes pupils to omit letters or to transpose letters in a word.

(e) SENSITIVENESS. A child who has a nervous temperament, or who is abnormally sensitive, often becomes confused and writes forms which he did not intend to produce.

(f) POOR TEACHING. The results obtained in spelling depend far more upon the methods employed than upon the time spent upon spelling exercises. The teaching of spelling rarely receives the attention which the importance of the subject warrants, and it is probably true that poor teaching is the most prolific source of the poor spelling charged against the schools.

4. Psychology and Spelling. The old definition of spelling is, "The formation of words by letters;" and too many teachers have confined their notion of spelling closely to this definition. If one would be successful in teaching spelling, one must understand the mental processes involved; and examination shows that these are somewhat complex. Considered from the activities involved, spelling is a *sensori-motor* habit; that is, it includes the action of some of the organs of special sense—sight and hearing and muscular movement, which, in oral spelling, brings the vocal organs into action, and, in written spelling, the muscles involved in writing. It naturally follows that all of the activities connected with spelling should be brought to bear upon it. Oral spelling and written spelling are both valuable, and the results of numerous tests show that the highest percentage of accuracy is secured when both are employed. The successful teacher of spelling will, therefore, use all proper means to fix the words permanently in the minds of the pupils.

5. Selection of Material. There are wide differences of opinion among educators as to the sources from which words for spelling exercises should be taken. One group strongly advocates the use of the spelling book, and the other is emphatically opposed to it.

(a) THE SPELLING BOOK. Those who advocate the use of the spelling book base their claims chiefly upon the following arguments:

(1) The spelling book contains lists of words, systemat-

ically arranged and carefully graded. These are much better lists than can be prepared by the teacher.

(2) Words selected from various branches pursued by the pupils, while they may meet the immediate needs of the schoolroom, do not give the child a sufficiently broad vocabulary to meet the requirements of later life.

(3) Words selected at random are not graded in the order of difficulty, neither are they chosen according to any system.

(4) In copying words into their note books, children are liable to make mistakes in spelling, and thus provide themselves with wrong forms for study.

(b) OTHER SOURCES. The opponents of the spelling book raise the following objections to its use:

(1) Lists of words in most spellers are not suited to the needs of the pupils. They contain many words which the pupil already knows, therefore does not need to study, and many others which he will seldom, if ever, use. Time spent in learning to spell these words is wasted.

(2) Compelling pupils to study words whose meaning and use they do not know destroys all interest in the spelling exercises and therefore violates an important pedagogical principle. One of our leading educators even goes so far as to say, "It is doubtful whether the modern spelling book, with its barren lists of words, made up on the principle of similarity of sound, is not the greatest foe of good spelling."[1]

(3) Since spelling is a practical study, and since in life we spell words only when we write them, spelling should be so related to other studies that its utility will always be apparent. When the spelling book is used, this feature is often lost sight of.

(c) PRINCIPLES OF SELECTION. Between these opposing elements, with their various arguments, the inexperienced teacher is liable to be left in doubt as to the best course to pursue. If she has a course of study, it usually provides for the work in spelling as well as in other branches; but if without a guide, she is often under the necessity of making her own selections. Under such conditions she will find the following principles helpful:

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[1] Superintendent W. H. Maxwell.

(1) Select words in common use. Mistakes are more frequently made in the spelling of common words than uncommon ones. When the child has occasion to use an uncommon word, he looks carefully at its form, and learns its spelling.

(2) Select words somewhat difficult to spell. Phonetic words, as *man*, *men*, *lake* and *time*, require little or no attention; but such words as *sight*, *journey*, *thought*, *foreign*; and all others containing silent letters, require a great deal of attention, because their pronunciation does not indicate their spelling. The child misspells many common words of this kind because he knew them by sound long before he saw their form, and his tendency is to spell them phonetically. The association between the phonetic form and the authorized form, as in *jerney* and *journey*, must be broken before the child will spell words of this class correctly.

(3) Select the new words from the lessons in the various branches as they are met from day to day. The spelling of these, however, should be in connection with the regular lesson on the branch in which they are found. A list of these words should be kept by the teacher, and the list can occasionally be used for a review lesson.

(4) A good spelling book is usually a safe guide, especially for the inexperienced teacher. In the rural school it is practically a necessity, because the teacher cannot find time to make suitable selections of words for the different classes. The spelling book, however, should not be relied upon too implicitly. Combinations of lessons taken from the spelling book, with others formed of words selected from the different branches, will yield the most satisfactory results.

6. The Lesson. We have already given the psychological reasons for having both oral and written exercises in spelling, but the spelling lesson demands more attention than it usually receives.

(a) ASSIGNMENT. The lists of words selected for spelling should be scrutinized with care. If taken from the spelling book, the list may contain words which the pupils already know. They should not waste time studying these words, but unless their attention is called to them when the lesson is assigned, pupils in the fourth and fifth grades will spend as much time studying words they know as those they need to learn. Words difficult of pronunciation should have their pronunciation given at the assignment of the lesson. In short; all known difficulties to the study of the lesson should be removed when it is assigned.

(b) THE RECITATION. The spelling recitation should be devoted to spelling, and to spelling only. The study of diacritical marks, pronunciation, derivation and kindred topics should be taken up in other exercises. Their introduction into the spelling exercise leads to confusion.

If the exercise is oral, the pupils should pronounce the word after the teacher, then utter each letter distinctly, dividing the word into syllables by slight pause between them; as in spelling *compound*, the pupil will spell *com* (pause) *pound*. If the exercise is written, pencils, spelling slips, or blanks, should be ready for use before beginning to pronounce the words. Secure the attention of the class, then pronounce the word clearly and distinctly, and *but once*. Repetition leads to inattention and carelessness.

If it is a dictation exercise, choose short sentences which the pupils can understand, and dictate the entire sentence at once, but do not repeat it. Give the pupils ample time to write the sentences, for haste leads to poor spelling.

7. Correcting Errors. The correction of errors is the rock upon which many teachers of spelling become stranded. Too many teachers see so many misspelled words, and nothing more, when the important thing is to analyze the errors, and to the extent of your ability discover the causes which led to them.

(1) So far as possible prevent errors. This is even more important than correcting them, since every time the child

misspells a word, he strengthens his tendency to spell it that way again. Many errors can be prevented if, before writing, the teacher calls attention to those words which are liable to be misspelled. Whenever new words are encountered, attention should also be called to their spelling before the class attempts to write them.

(2) Give the pupil opportunity to correct his errors before he passes his work out of his hands. The purpose of the exercise is to train the pupils in spelling, not to see how many errors they can make. The practice of allowing pupils to correct their own errors encourages them and leads them to put their best efforts into the spelling exercise. Furthermore, it is only justice to the children; they should have the same chance to correct their work that you claim for yourself. Doubtless you seldom allow a letter or other piece of written composition to pass out of your hands until you have looked it over for errors in spelling, punctuation and grammatical construction.

(3) The method of correcting errors will vary with the conditions under which the exercises are given. After the pupils have reviewed their exercises, it is a good plan to have them exchange papers, and as the teacher spells the words, have each pupil check the errors on the paper in his possession. When all of the words have been checked, the pupil correcting the paper should sign his name, or place his initial, at the bottom. The papers should then be returned to their owners, who should proceed at once to correct their errors. This matter of correction should not be left until the pupil studies the next spelling lesson; before that time he may have occasion to write the misspelled word several times, and he will repeat the error each time.

(4) Analyze the errors. This is very important, since it gives a clue to the causes of most of them. Some errors will be found common to the class, and can be treated in special lessons; others will be peculiar to individual pupils, and each pupil to whom this class of errors applies should receive such attention as will enable him to overcome his

difficulty. Some of the errors of this kind are the following: The use of *m* for *n*; transposition of *e* and *i* when they occur together in a word and associating the spelling of words which have similar sounds but are spelled differently, as *scope*, *sope* (soap); *meet*, *wheet* (wheat). The child has both words in mind, and lets the first govern the spelling of the second.

(5) Encourage your pupils to do their best. Emphasize the number of words spelled correctly, rather than the number of errors made.

(6) Have the pupils write, again and again, sentences and paragraphs which will include words they are prone to misspell. Follow up each error until the correct form is firmly established. A few words each day studied on this plan will accomplish much more towards securing good spelling than the learning of long lists of words which receive little attention.

(7) Have each pupil write correctly in the back of his spelling blank the words which he misspells at each exercise; later, give him frequent tests on these words.

8. General Suggestions. (1) The final test of one's ability to spell is one's spelling in written composition. Many pupils who spell words correctly when writing them in columns, misspell the same words in paragraphs, and even in short sentences. Therefore, the plan of having pupils write their spelling exercises in sentences and paragraphs which shall include the words studied, should be adhered to closely.

(2) Avoid too long lessons. Pupils in the fourth and fifth grades can master but a few words in a day. Long lessons lead to confusion.

(3) Seventh and eighth grade pupils can often study the structure of words to advantage. A knowledge of derivation and structure is an aid to spelling. For instance, we are more liable to spell *laboratory* correctly if we know it comes from *labor*. A plan for this work is found in Teacher's Guide, *The Dictionary and How to Use it*. The work, however, should be considered as word study, not spelling

9. Rules for Spelling. Most of the rules for spelling contain so many exceptions that they are of but little practical value. However, the following contain comparatively few exceptions, and can be learned with profit by pupils in the grammar grades. Before they are introduced, the pupils should have a few lessons on vowels and consonants:

(1) Most words ending in silent *e* retain the *e* before suffixes beginning with a consonant; as *home*, *homely; like*, *likely; care*, *careless.*

(2) Most words ending in *y* preceded by a vowel, retain *y* before a suffix; as, *gray*, *grayish; pay*, *payable; journey*, *journeying.*

Exceptions. Daily, *laid*, *paid*, *staid*, *saith*, *said.*

(3) Words of one syllable, and words of more than one syllable with the accent on the last syllable, ending in a single consonant preceded by a single vowel, double the final consonant before a suffix beginning with a vowel, except when the addition of the suffix throws the accent nearer the beginning of the word; as, *prefer*, *preferred; star*, *starry; refer*, *reference*, *referred.*

(4) Words of more than one syllable, with the accent not on the last syllable, ending in a single consonant, do not double the final consonant before a suffix beginning with a vowel; as, *travel*, *traveler; group*, *grouping; answer*, *answered.*

TEST QUESTIONS

1. To what extent are rules for spelling valuable? Show why the application of these rules is limited.

2. Do you favor the use of the spelling book? What advantages do you see in its use? What disadvantages?

3. What instruction for studying their lessons from a spelling book would you give pupils of a fourth grade?

4. Explain your method of correcting errors in your spelling classes. In what respects do you find it defective? How can these defects be remedied?

5. Show how a study of derivation in the grammar grades assists pupils in learning to spell.

CHAPTER EIGHT

PENMANSHIP

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1. Value. Writing is one of the arts which should be acquired by every child before the end of the school period of his life. While the public schools are not expected to make professional penmen of their pupils, they are expected, and should be required, to so train the children that by the time they have completed the work of the fifth grade they can write an even, legible hand with ease and with a fair degree of rapidity. This is the least that will meet the demands of one's business and social relations. Many positions can be filled only by those who write a neat and legible hand. It is an imposition upon one's acquaintances and friends to send them written communications which cannot be easily read. Moreover, serious mistakes are often made because people do not write plainly.

In the chapter on *Penmanship* in Volume II, the foundation for teaching this branch has been laid and it will be well for the teacher to study that chapter in connection with this. Moreover, many of the exercises there given are just as valuable for pupils in the fourth and fifth grades, as they are for those in the third grade. Correct position, right movement and continued practice, are the essentials of successful work in penmanship.

2. Conditions Frequently Met. When pupils enter the fourth grade, all habits are in a formative stage. However careful their previous training in penmanship may have been, correct habits of position and movement are not firmly fixed. After the long summer vacation the children will be out of practice, and some of them, at least, will be unable to recall readily the details which they learned in the previous grade. The writing of many of these children will be characterized by wavy lines and poorly formed letters. Some, especially among the girls, will have acquired the finger movement, and their written characters will be so small as to be scarcely legible.

These conditions are due chiefly to four causes—a faulty position at the desk, the child's inability to control his muscular movements, lack of knowledge of the forms of letters, and spending time and energy during the writing period in copying forms instead of in drills designed to fix correct writing habits. Before good results in penmanship can be secured, these difficulties must be overcome. It is, therefore, well for the teachers of intermediate grades to begin the year's work in penmanship with those exercises which are essential to success in this branch.

3. The Teacher's Viewpoint. Many teachers fail to secure satisfactory results in penmanship because they do not study the problem carefully or plan their work systematically. Penmanship is placed in the course of study that children may be taught to write legibly, easily, and with a fair degree of rapidity. The writing lessons are a means to this end, and the teacher should look upon the work in this branch from the viewpoint of its purpose. Writing, when considered from the point of view of its function in a course of study, is vastly more than the copying of forms. Writing is reproducing with pen or pencil the forms of letters which the writer holds in mind, and the combining of these letters to form the words required to express his thought. Every lesson in penmanship has its psychological as well as its physical or muscular phase. "All principles of pedagogy apply to penmanship."

4. The Teacher's Preparation. Too many teachers overlook the psychological phase, or mind side of the subject, when preparing their writing lesson. Unless this phase of the work is most carefully considered, it is impossible to secure the desired results. "The three essentials in teaching writing are form, freedom and interest."[1] Of these, form and interest belong to the mind side of the subject.

(a) FORM. Before the architect can draw the plans for a building, he must have a clearly defined picture of the structure in his mind. Just as truly must the pupil have in mind definite images of the letters before he can write them. Form, then, is in the mind, and the acquisition of form is a mental process. So long as the child is dependent upon the copybook or the blackboard for the forms of the letters, he cannot express himself in writing. The child acquires the forms of letters by observation, by studying them in books, and by seeing them made on the blackboard by the teacher. He fixes these forms in mind by making them himself. Therefore, the teaching of form is one of the first essentials in teaching penmanship. The steps are (1) observation, (2) formation of mental images, (3) reproduction of the forms learned.

(b) FREEDOM. By freedom is meant the ease and skill which characterize one's writing. The acquisition of freedom constitutes by far the greater part of the work of learning to write, and a large portion of this lesson is devoted to exercises which will enable the teacher to assist her pupils in securing this much desired end.

(c) INTEREST. Interest is the appeal which the subject makes to a child. In nearly all cases the interest which the pupils take in their penmanship depends upon the skill with which the teacher plans the lesson and the zeal and enthusiasm with which she conducts the exercises. The teacher who plans her lessons wisely, and is enthusiastic, will have little or no difficulty in securing and retaining the interest in the writing lessons. All the principles and laws of interest which apply to other branches apply here with equal force.

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[1] B. D. Berry: *The Penmanship Trinity.*

(d) Applications. From the foregoing discussion it is clearly seen that the teacher should prepare her lessons in penmanship with as much care as she does those in other branches, and that the lessons should be systematically arranged and properly graded. The teacher should have a definite plan, and should proceed by the most logical steps to reach the end in view.

5. The Elements of Form. In learning to write, the child has to observe, memorize and make sixty-one characters—twenty-six small letters, twenty-six capital letters and nine figures. Were each of these characters formed on an entirely different plan from the others, the task, though somewhat formidable, would not be beyond accomplishment with a reasonable degree of effort. The problem, however, which confronts the child and the teacher is much more simple. These sixty-one characters are all formed from two simple elements—the straight line and the oval, by combining them in different ways. It naturally follows that children who acquire the power to make these elements with ease, skill and rapidity, become free, easy and legible writers. In all drill exercises the teacher should hold this idea in mind. The exercises given in the following pages are for the purpose of showing how the elements are modified and combined to form the different characters and how by their use the pupil may acquire skill in writing.

6. Position. Good position at the desk is essential to free and easy movement. Unfortunately, some school desks are so narrow that the preferred position cannot be taken. The front position is the most desirable, and whenever practical this should be assumed in all writing exercises. The pupil should sit erect, facing the desk, with both feet squarely on the floor. The body should be approximately erect, but may bend forward slightly, provided the bending is at the waist. Keep the spine straight. The pupil should not lean against the desk, nor against the back of the seat. Fig. 1

shows the position of the arms and paper. A is the right arm, B the left arm, P the paper, and D the desk. It will be noticed that the angle which the paper forms with the front of the desk is about one-third of a right angle; in other words, if the line which represents the lower edge of the paper were extended to the right edge of the desk, it would touch a point one-third the distance from the lower to the upper corner.

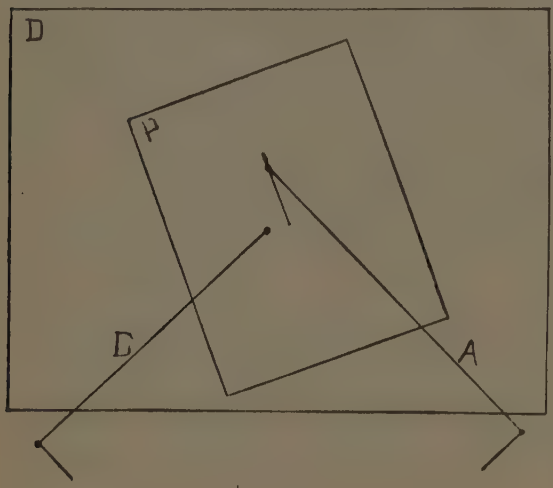


FIG. 1

The desk should be of such a height that when the writer sits erect, and lets his arm drop naturally at the side, the top of the desk will be a little higher than the elbow. For the adult, the writing should be from twelve to fourteen inches from the eye. When writing, both arms should be upon the desk, the right hand guiding the pen and the left holding the paper in position.

When school desks are too small to admit of the front position, the pupils may be permitted to assume a side position, in which the body is turned to the right, so that a line running from the right to the left side will form an angle of about 45° with the front of the desk.

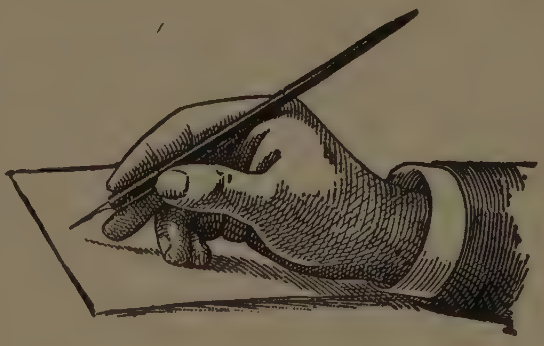


FIG. 2

7. Holding the Pen. The pen or pencil should be held loosely between the thumb and the first and second fingers, the thumb coming beside the first joint of the forefinger. The pen should point to the shoulder, as shown in Fig. 2. The ends of the last two fingers are the only part of the hand which should touch the paper, and these finger-tips should glide lightly over the page. The first and second fingers should be nearly straight.

The forearm should rest upon the large cushion of muscle between the elbow and the wrist, and the hand should be in such a position that the under side of the wrist is nearly parallel with the surface of the desk, as shown in Fig. 3.

Caution. "Eternal vigilance" is the price of good results in writing. The necessity of insisting upon correct position and proper holding of the pen in every written exercise cannot be too strongly emphasized. Unless the pupils follow the directions given in Sections 15 and 16 until these positions become habitual, they will never make free and easy writers.

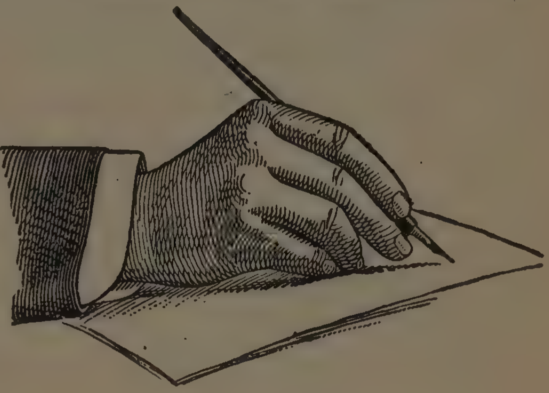


FIG. 3

8. **Movement.** Three movements are recognized in writing. These are the muscular, the arm or whole arm, and the finger movements. While all are used to a greater or less extent, the muscular movement is the only one which should be used for general writing. The finger movement is sometimes combined with this for forming the long stem and loop letters, but such a combination should not be freely resorted to. The arm movement is useful when very large writing is desired, but it is seldom called into use.

In the muscular movement, all forms except the long loops and stems, for which the fingers may be used, are made by the hand and arm, the fingers remaining in a fixed relative position. This movement is the one in general use by accountants, clerks and others who are engaged in constant writing with a pen. It is also the movement taught in business colleges and advocated by most systems of writing introduced into the public schools. It secures the best results with the least effort, and can be practiced longer than either of the other movements without fatigue. The finger movement, except for purposes already mentioned, should not be allowed. Train your pupils in the muscular movement, if you would secure the best results.

9. **Preparation for the Lesson.** When the writing period is reached on the daily program, all other work should be set aside, and the teacher should give her entire attention to the writing lesson. The work should be characterized by order, system and despatch. The desks should be cleared, the writing material should be quickly distributed, and the lesson should begin at once. If the pupils care for their own writing material, it should be placed on the desks promptly and quietly. If the material is to be distributed, monitors appointed for the purpose should attend to this duty without any attention on the part of the teacher. There should be enough monitors to distribute the material in about one minute.

10. **Material.** For drill exercises a good quality of unruled writing paper, 8½ x 11 inches, is the most suitable. The pen should have a smooth point and be of medium grade of fineness. Coarse pens, stubs and very fine pens are not suitable for these exercises, but the children in the intermediate and grammar grades may use a finer pen than those in the primary grades. The penholder should be reasonably large, and composed of cork or rubber. Metallic holders should be avoided, since they are more difficult to hold and cause fatigue in a short time. A good quality of black or blue-black ink should be used.

11. **Methods.** Before the carpenter can make close joints, he must learn how to use his tools with skill. Likewise, before the child can write easily and legibly he must learn how to use his pen. This fundamental principle is overlooked by those teachers who consider the chief purpose of the writing lesson to be the copying of forms from a writing book. While the writing book furnishes correct forms for study and excellent exercises for occasional practice, and therefore has its place, it should occupy only a limited portion of the time devoted to the writing lessons. It is impos-

sible to secure the necessary freedom of movement by the use of the writing book. The moment the engraved copy is placed before the child, he becomes a slave to it, and position and movement are at once lost to view in his effort to reproduce the forms in the copy. A glance over any writing class which relies chiefly upon the book for practice reveals the futility of attempting to teach writing in this way.

The teacher must therefore conduct many drills which have for their purpose the formation of right habits of position and movement. While freedom is an end sought, it must be remembered that freedom does not mean "license to do as you please," but orderly, well-directed movement. All exercises should have a definite purpose, and the pupil should have this purpose clearly in mind. The old adage, "Practice makes perfect," must here be modified to "Only right practice makes perfect in penmanship."

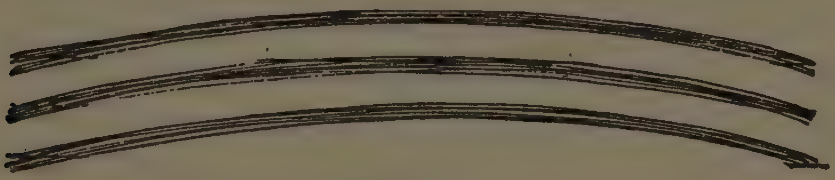
At the beginning of each writing lesson, call attention to position, and see that each pupil assumes the correct position before the practice begins. As the exercise progresses, move quietly among the pupils, correcting faulty positions and wrong movement. It is only by persistent individual work of this sort that satisfactory results can be obtained. Praise effort; encourage those who become despondent; try to see something to commend in the work of each pupil, but criticise defects and keep a high standard of excellence before the class.

12. Preliminary Exercises. The first exercises should be designed to make the pupils feel at ease in the writing class, and to impress upon them the importance of correct position and movement. In these exercises no attempt should be made to form characters.

(1) When the class is in position, with pens in hand, have them move the right hand from left to right and back several times, using as a pivot the cushion of muscle upon which the forearm rests. There should be little or no motion at the wrist joint, and in no case should the wrist joint form

the pivot upon which the hand moves. The hand should glide over the paper on the tips of the third and fourth fingers, as in regular writing.

At first let the movement be made without marking upon the paper. Uniformity of movement is secured by counting. When the class is in position, say, "Ready. Right, left; right, left; right, left; one, two; one, two;" and so on. Continue the counting for about a minute, then pause for a brief rest. Be sure that the hand is held so that the penholder points to the shoulder. After two or three exercises like this, let the pupils mark upon the paper for a few exercises. The result should be similar to that represented in Exercise 1.

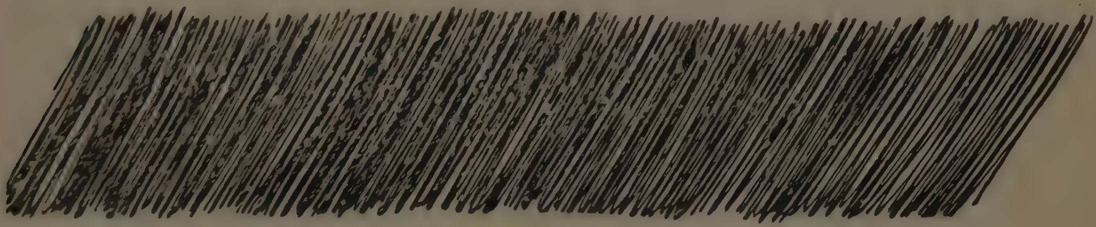


EXERCISE 1

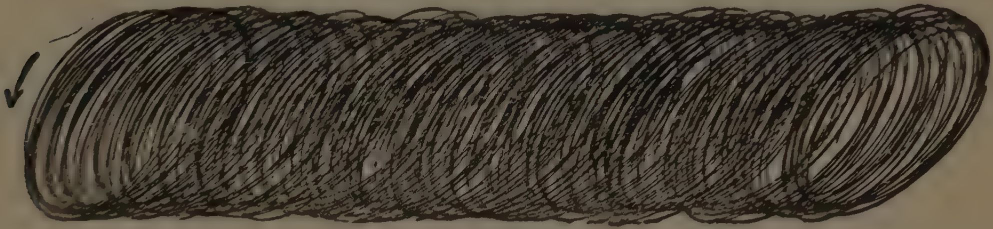
For the first few exercises it may be well to say nothing about the length of the lines, but as soon as the pupils become accustomed to the movement, the length should be restricted so that it will not exceed four inches, and better results are secured with a length of about three inches. Three or four minutes can be spent profitably in such drill at the beginning of each writing lesson.

(2) The next drill gives practice on the straight line. The movement is made by allowing the hand to play forward and backward on the paper, while the forearm rests upon the desk, as in Fig 1. The slant will depend upon the way the pen is held, and probably it will not be exactly alike in any two cases. This, however, need not cause any concern. Regulate the movement by counting, as in the first exercise. Begin without marking, and then use the ink. This exercise is more difficult than the first, and there will probably be more irregularity in the work of the pupils. The result sought is seen in Exercise 2.

(3) The third exercise is on the second element of form—the oval. The forward and backward motions are the same as in Exercise 2; but while the hand moves forward and backward, it also moves from right to left, so as to form the oval. Regulate the movement by counting "one" on each down stroke. This exercise should be resorted to again and again, until the pupils can reproduce Exercise 3 with ease and rapidity.

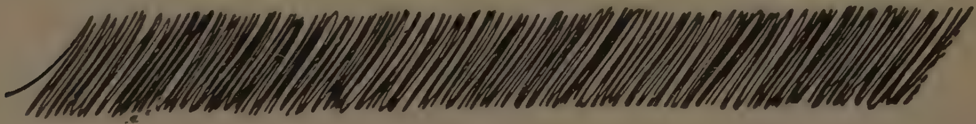


EXERCISE 2

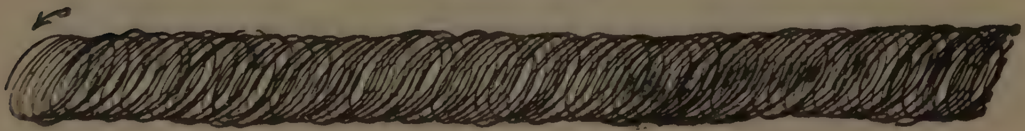


EXERCISE 3

Exercises 2 and 3 should be practiced until they can be written in smaller size, as illustrated in Exercises 4 and 5.



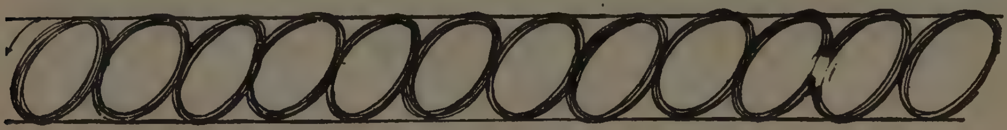
EXERCISE 4



EXERCISE 5

Sixth, seventh and eighth grade children should be able to do this with but little preliminary drill.

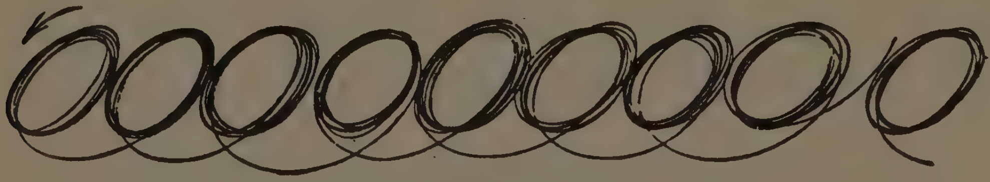
(4) The next exercise shows the separate oval, which is the best form for all characters or parts of characters containing curves (Exercise 6). The movement in this drill should be regulated by counting, as in the continuous oval. The drill should be practiced at nearly every writing lesson in the fourth and fifth grades.



EXERCISE 6

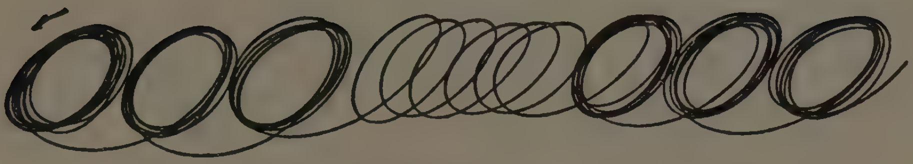
13. Development of Forms. Variety in exercises and plans is necessary to maintain interest. (1) After the pupils have produced the continuous oval in the ordinary way, with the down stroke on the left, let them practice with the movement reversed. This drill should be repeated until the children become as proficient in making the continuous oval with the reverse movement as they are in producing it by the movement shown in Exercises 3 and 5.

(2) Exercise 7 is produced by the same movement as Exercise 6. Joining the ovals by a swing to the right is designed to give greater freedom in movement. Count on each down stroke. When an oval is completed, pass to the next on the word *and*; as, "Ready. One, two, three, four, five; and one, etc.," until the line is completed. This is an excellent drill and should be often repeated. From Exercises 6 and 7 the pupils get the idea of the formation of O.



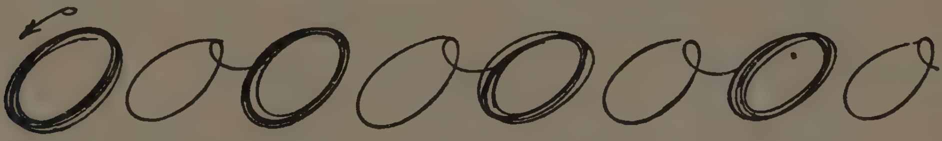
EXERCISE 7

(3) In Exercise 8 an additional step is given, in the formation of the single line ovals in the center of the figure. Observe the directions given in Exercise 3, Section 21.



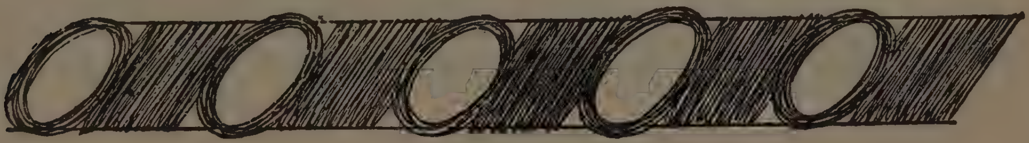
EXERCISE 8

(4) In Exercise 9 the O alternates with the oval. This exercise shows the pupil's power of control over his movements. If the O's are even and light, he has gained such control as will insure his becoming a good penman.



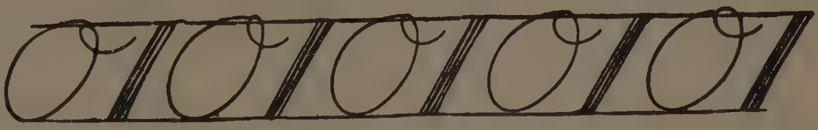
EXERCISE 9

(5) In Exercise 10 we have a combination of the elements of form. This exercise should be preceded by drills on Exercises 4 and 6, in Section 21. It is more difficult than those which have preceded it. The tendency will be to make the straight lines longer than the long diameter of the ovals. Count on the down strokes. When the class can reproduce this exercise as given, it shows excellent progress.



EXERCISE 10

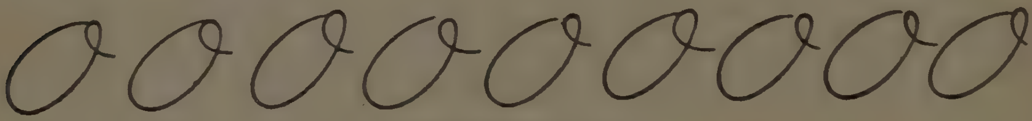
(6) In Exercise 11 the straight lines and ovals are separated, the latter appearing as O's. Count "one" for each O and "one" on each down stroke in the straight lines; as,



EXERCISE 11

"one, and one, two, three; one, and one, two, three," etc. Light lines and even strokes in all characters should be the aim in this drill.

(7) In Exercise 12 the O's are given alone. All steps in the development of this letter are now completed, and the O stands by itself. Count "one" for each O.

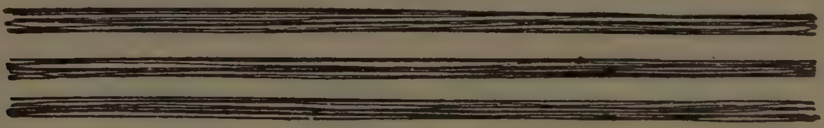


EXERCISE 12

(8) In Exercise 13 we return to the movement with which we began, except that the hand now moves in a straight line instead of over the arc of a circle. Practice the first exercise in Section 21, then change to this:

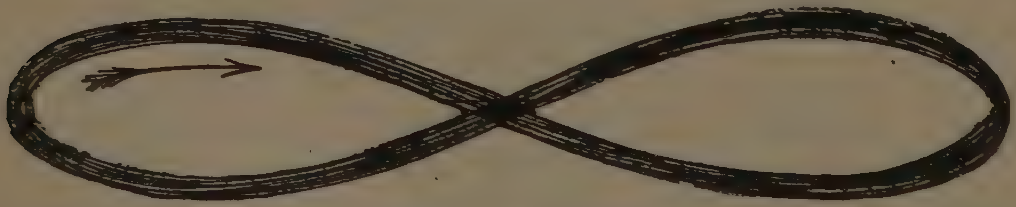
EXERCISE 13

The pupils will discover that the straight line is more difficult to make, and that there must be no motion at the wrist. After practicing a few minutes on Exercise 13, change to 14. These drills are valuable in training pupils to write in straight lines on unruled paper.



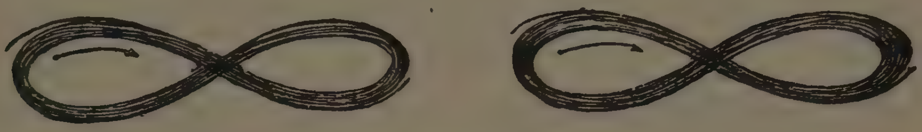
EXERCISE 14

(9) In Exercises 15 and 16 the right and left and oval movements are combined. Produce these forms first by moving the hand as indicated by the arrows, then reverse the movement for an equal number of figures. Exercise 15



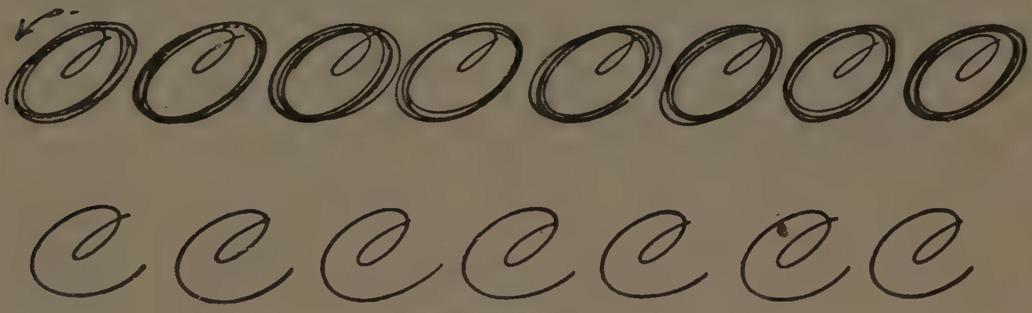
EXERCISE 15

affords good opportunity for practicing the whole arm movement, if this is desired for variety. This is the most difficult exercise yet given, and its mastery marks a good degree of progress in gaining control of the muscles. Exercise 16 reduces the same exercise to one employing muscular movement only.



EXERCISE 16

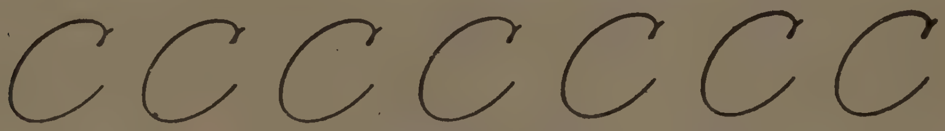
(10) Exercise 17 shows the evolution of C from the oval. Begin by forming the small loop in the upper part of the oval.



EXERCISE 17

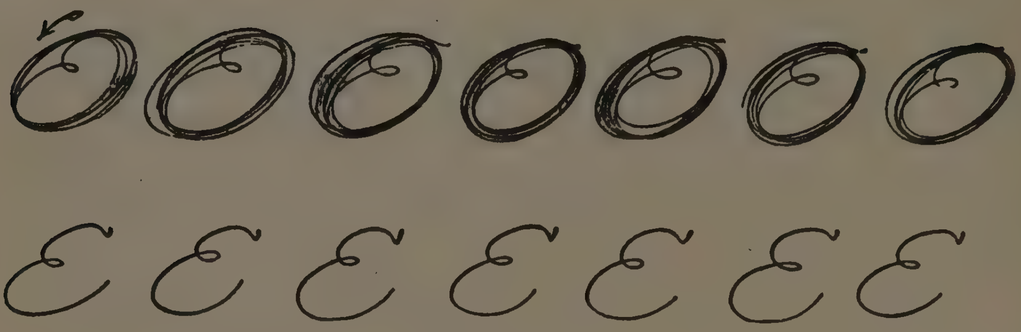
Count as in the formation of other ovals. In the lower line the oval is dropped and the C's stand out alone.

Exercise 18 shows a simpler form of C, but one more difficult to make, because of the small loop at the beginning. The drills on ovals should enable the pupils to make C's of even size and light lines. Practice until this result is reached.



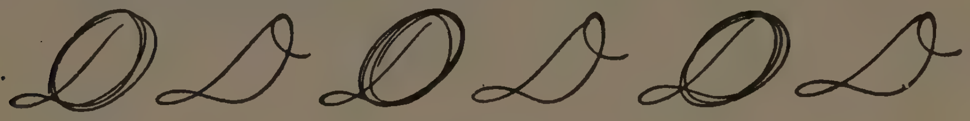
EXERCISE 18

(11) Exercise 19 shows the evolution of E from the oval. Make the oval, then the E within it. Count as in other exercises. In the lower line we have the E standing alone. Many lines of E's should be made.



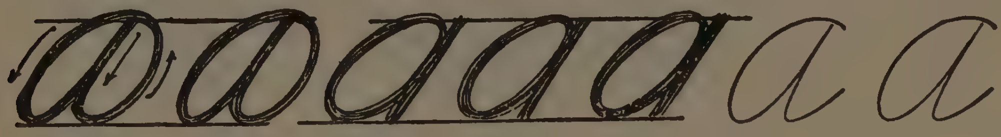
EXERCISE 19

(12) D starts with a downward line slightly curved, forming the left side of the letter, and ending in a small loop at the bottom. The oval is then made around this, to give an idea of the general form of the letter. Alternate ovals and D's are shown in Exercise 20; practice faithfully until the pupils can form the letter readily.



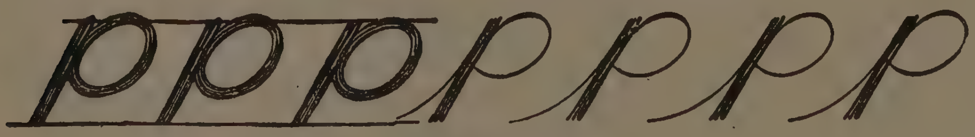
EXERCISE 20

(13) A is a combination of the oval and the straight line. Exercise 21 begins with the downward stroke indicated by the arrow in the center of the first character. Carry the pen around, forming the outside of the large oval. Let the pen turn upward to form the right side of the left oval, then bring it down on the first line formed. Practice on these figures until the pupils have acquired the movement. The transition to the A is then simple and easy.



EXERCISE 21

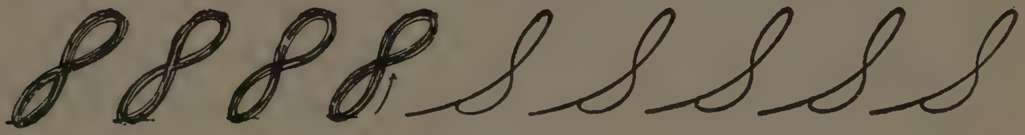
(14) In the formation of P the full straight line and the



EXERCISE 22

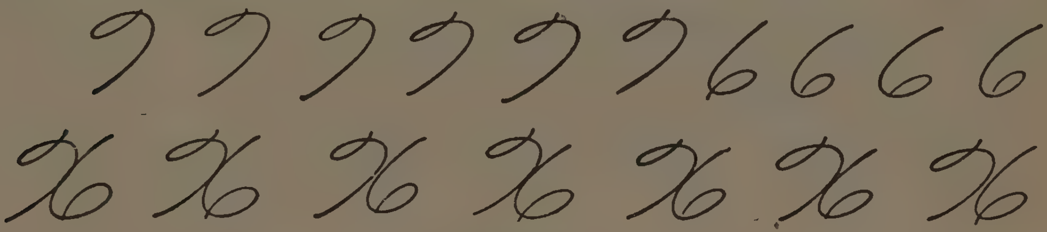
small oval are combined. Practice the straight line first, then join the oval to it. The transition to the letter is evident.

(15) S is formed by the movement which produces Exercise 16 turned in a nearly vertical position. It is a good plan to alternate this drill on the figure with the letter.



EXERCISE 23

(16) Exercise 24 gives the elements used in forming parts of several capital letters. The first four characters of the

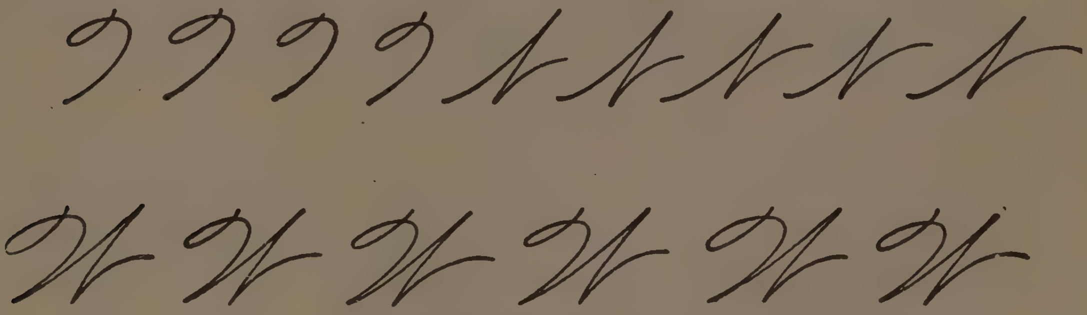


EXERCISE 24

first line form the first part of M, N, W and X; the last six form the last part of X and the figure 6.

The last line of the figure shows the elements combined to form X.

(17) In Exercise 25 we have the elements which unite to form W. The first four characters of the first line are the same as the first four in Exercise 24, and the last five of the



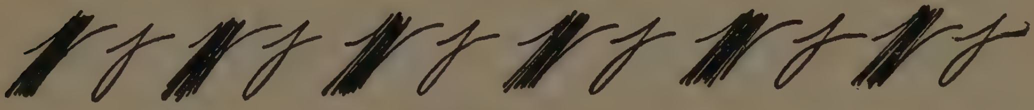
EXERCISE 25

first line resemble *t* when it is written as the last letter of a word. This should first be formed separately and then united to form W, as shown in the last line of the figure. This capital is usually faulty because pupils do not have a clear idea of its correct form. The drill here given is calculated to fix the form in their minds.

14. Small Letters. No new principles are involved in forming the small letters. The movements already described are used here only on a smaller scale. When loop or stem letters occur in the middle of a word, the fingers are often employed to form the loop or stem, while the regular muscular movement is used in making the other letters. Since the small letters constitute the great body of writing, they require a proportionate amount of practice. One's penmanship is characterized by his small letters. If these are light, even and well formed, one is said to be a good writer. A pupil's writing is poor just to the extent that his small letters fail to reach the standard here given.

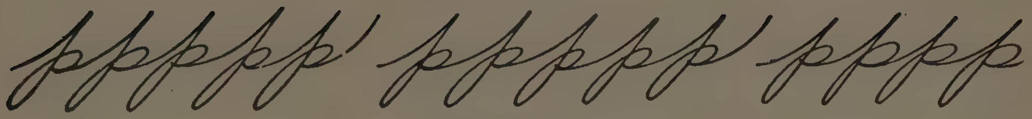
The teacher should illustrate the evolution of the small letters, and lead the class to see clearly how the drill exercises are related to their formation. Always keep the simplicity of the problem in mind. When the pupils have learned the foundation movements well, they have practically learned to write.

(1) Exercise 26 again introduces us to the straight line drill, and shows how *j* is developed by this exercise. Have the pupils make several lines of these figures, then change to the letter, and write a page or more of *j*'s. Continuous practice on one character is necessary until the class has acquired the ability to make it easily and in good form; in this way every lesson is a step forward.



EXERCISE 26

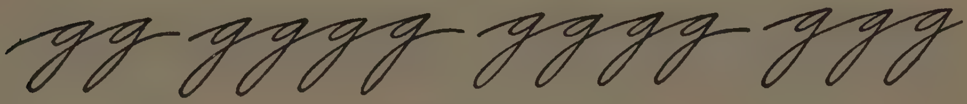
(2) Small *p* combines the stem and loop. It is well to use the straight line drill with this exercise also. Exercise 27 shows a good style of letter and one easily made. This



EXERCISE 27

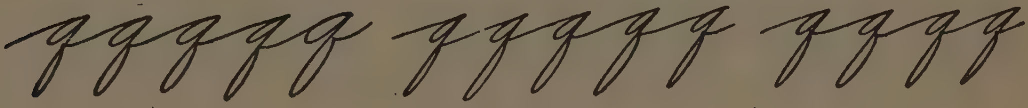
is a somewhat more difficult exercise than the preceding, and it will require considerable practice.

(3) Small *g* combines the oval and the loop below the line. The loop is most easily made by the finger movement. Exercise 28 furnishes a good copy for this exercise.



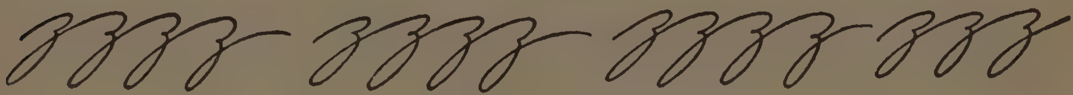
EXERCISE 28

(4) The change from *g* to *q* is very simple, as shown in Exercise 29. The loop is made by carrying the hand to the right of the downward stroke, and joining the line thus formed to the first line just below the oval. This movement is not used as frequently as that employed in making the *g*, and the exercises will require frequent practice.



EXERCISE 29

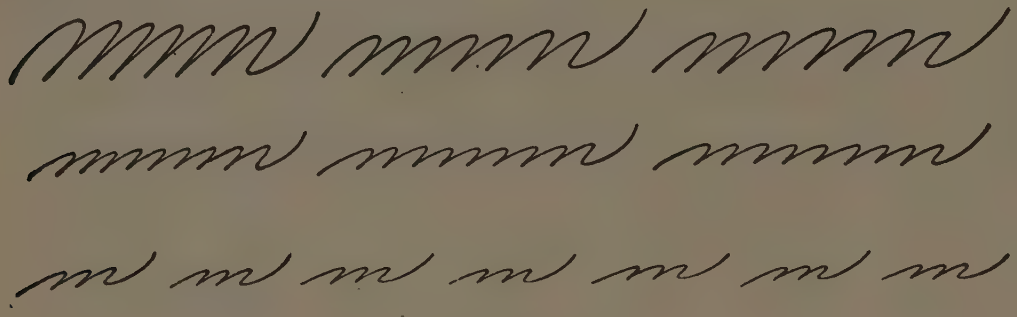
(5) Exercise 30 illustrates the formation of *z*. The part of the letter above the line will require care, since it calls for a movement not often made. It will also be noticed that the down stroke in the loop bends to the right more than in the *g*.



EXERCISE 30

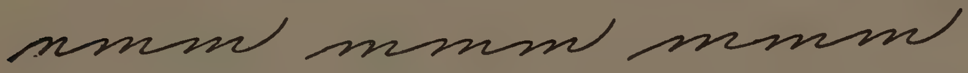
(6) Exercise 31 is a drill exercise which should be used as a preparation for *m* and *n*. This exercise is evolved from the reverse oval by making a narrow curve with the upward stroke and a straight line with the downward. This drill

should be practiced until the movement produces small, even lines, as shown in the second line. From this the transition to single letters (as shown in the last line of the figure) is very easy.



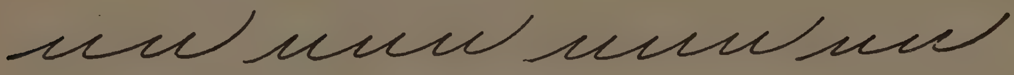
EXERCISE 31

Combination of *m* and *n* and grouping of m's should follow.



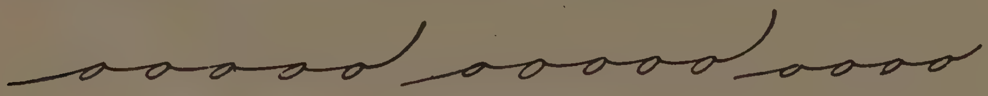
EXERCISE 32

(7) Small *u* is formed with the same movement as *m* and *n*, except that the curve is at the bottom. Exercise 33 gives a good exercise for practice. It should be noticed that *i* is one-half of the *u*, with the dot above.



EXERCISE 33

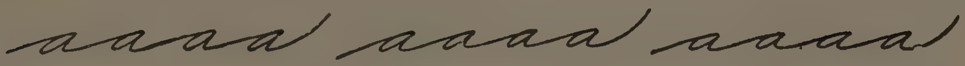
(8) In *o* we return to the complete oval. Make the characters small and even, and join them as shown in Exercise 34. The *o*'s should cross the page in straight lines. If pupils find it difficult to do this, return to Exercise 12, Section 22.



EXERCISE 34

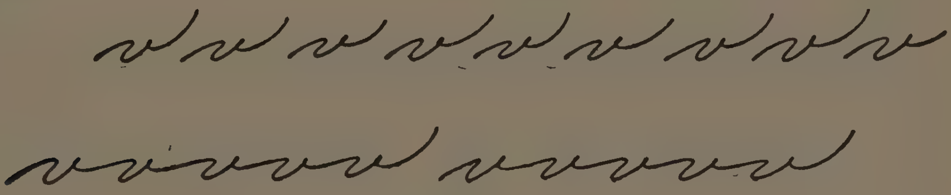
(9) Small *a* has the same form as the *a* practiced in Exercise, 21 Section 22. When pupils have gained control of their muscles, they should find no difficulty in reproducing

the copies as shown in Exercise 35. The directions given for small *o* apply here, as well.



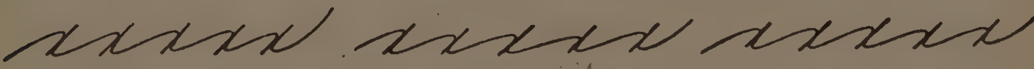
EXERCISE 35

(10) In making *v*, Exercise 36, notice that the first part is the first part of *n*, and that the upward stroke forms a part of the oval, but the hand is carried to the right, leaving the oval open at the top, and the letter is finished with a small loop and an upward movement of the hand. Connected letters, shown in the lower line of the figure, should constitute an exercise following that of the separate letters in the upper line.



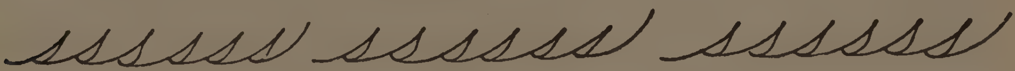
EXERCISE 36

(11) From a study of Exercise 37 it will be seen that *x* consists of the first part of *n* and a straight line. Make the curves first, then cross with a straight line.



EXERCISE 37

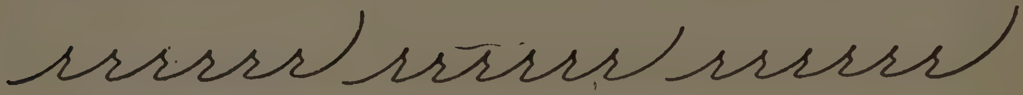
(12) In small *s* we have a letter slightly higher than *a*, *o* and *n*. A common fault in making this letter is failure to close it at the bottom. The s should receive careful attention in the drill exercises.



EXERCISE 38

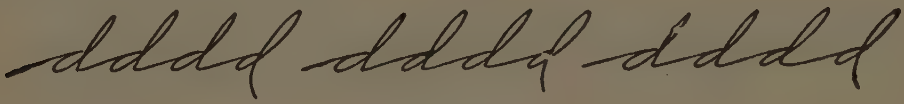
(13) Small *r* (Exercise 39) is the same height as *s*, but it is more difficult to make. The formation of the upper part of the letter requires care. This letter is often so faulty

that it is illegible; therefore, it should receive a good deal of practice.



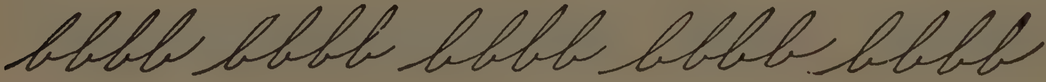
EXERCISE 39

(14) Small *d* (Exercise 40) consists of a small *a* joined to the stem, which, as in the illustration, is often written in the form of a loop.



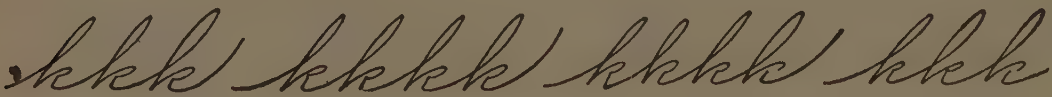
EXERCISE 40

(15) Small *b*, Exercise 41, consists of a loop with the right-hand part of the *v*. The tendency in making this letter is to give too much slant to the stroke forming the lower part. Considerable practice is necessary to overcome this tendency.



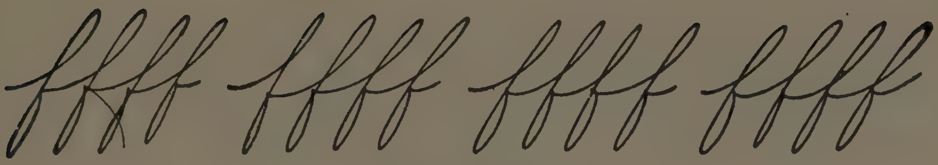
EXERCISE 41

(16) Small *k* (Exercise 42) consists of the loop and a character resembling a small capital *r*. The lower part of the letter requires careful attention.



EXERCISE 42

(17) Small *f* is the longest of the small letters. It consists of the common loop above the line and the *q* loop below. The line forming the left side of the loops should be nearly straight. The tendency is to give this line too great a curve.



EXERCISE 43

(18) The exercises for practice in this chapter will be found helpful and will lend interest to the work.

15. Relation to Other Subjects. Penmanship is closely related to all branches in the course of study into which written exercises enter. It frequently happens that in their written exercises in other branches the pupils violate all the principles which they have been taught in the writing lessons. So long as this state of affairs is allowed, good results in penmanship are impossible; therefore, through the intermediate grades, at least, every written exercise should be an exercise in penmanship, to the extent that correct position and movement are maintained. Written exercises in the fourth and fifth grades should be short, so that the pupils can have ample time to write them. Undue haste and lack of supervision in these exercises is one of the most prolific causes of poor writing found in the public schools.

16. General Suggestions. The following suggestions will be found helpful in planning and supervising the work in penmanship.

(1) Study is as essential as practice. Study yourself and lead your pupils to study the forms of the letters and the movements necessary to write them. You cannot reach high ideals by haphazard work.

(2) It is easier to form right habits than to break off wrong ones. See that each exercise in writing helps to fix proper habits of position and movement.

(3) Give attention to the little things. See that the writing material is kept in good order, and that it is so arranged that it can be distributed quickly. Make such changes of seats as will most nearly adjust the height of the desk to the pupils. Have the work for each lesson ready before the writing period arrives. Give such other attention

to details as may be necessary to make the work move along in a pleasing manner.

(4) Do not be discouraged nor allow your pupils to become discouraged over the results of the first few lessons. If the pupils have never used the muscular movement, they will not write as well by this movement at first and will want to continue in the old way. Impress upon them the importance of learning how to use the pen. When this is learned, all letters are easily made.

(5) Intersperse drill and regular writing in nearly all the writing lessons. This gives variety and enables the pupils to feel that they are learning to write.

TEST QUESTIONS

1. Show the importance of having children form good writing habits before they complete the fifth grade.

2. Why is attention to slant of little importance? How is form learned?

3. Give an outline of the preparation which you make for your penmanship lessons.

4. What are your greatest difficulties in teaching penmanship? How do you overcome them?

5. Why is penmanship so often neglected in schools? What are the most prolific causes of poor writing?

the mistaken notion that the only songs that interest the pupils are those which they learn in this way. They are much more interested in what they read, provided always the suggestion is followed of giving practice enough on each grade of material to enable the reading to be done with facility. Nothing so kills the spirit of a song as to have to struggle over its reading.

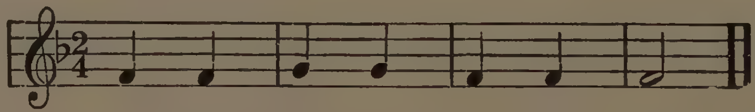
4. Rhythm and Tone. The two elements of music are time, or rhythm, and tune, or pitch. In planning a course of study, it is necessary to provide for the full development of each element. Every author of a graded course has attempted to keep the progress in the two elements about equal, some with more success than others. This lesson adheres to the order of development adopted by the majority of authors and the best authorities, so that the methods suggested can be applied to any series of books. Since there can be no music without the two elements of tone and rhythm, no exercise should be given without the two elements, unless it is absolutely necessary. A rhythm exercise may be, and should be, simple in tone. A tone exercise should be simple in rhythm. In writing an exercise, we often have to observe only one element at a time, but the separation of tone and rhythm should be avoided as much as possible.

5. Two Methods. Some teachers prefer to present all new problems by the purely imitative method. In the hands of a trained musician, who can skilfully lead from imitation to representation and interpretation, this method will be successful. For the average teacher with the average class, it is safer to show how the new problem is developed out of the old. In other words, to "proceed from the known to the related unknown." If, in certain cases, imitation seems to be the clearest and nearest route to the unknown, then it is the one to be followed. In the presentation of some problems, both plans will be suggested. The teacher should use the one which appeals most strongly to her.

FOURTH GRADE

6. Rhythm. The third grade rhythmic problem has two tones to a beat, of which ♩ = ♪♪ may be taken as the type. Most graded courses have this followed by what some call the beat and a half note, and others call the after-beat note. It does not matter so much what it is called, if the problem is understood as thus typified $\frac{2}{4}$ ♩. ♪. This is the use of a dot where it does not have the value of a full beat. The pupils have learned in the lower grades that a dot adds to the note half its original value. In the type given above, the dot has the same time value as an eighth note. Up to this time every tone or group of tones has always begun *on* the beat. In many instances a single tone has been held through two, or even three, beats, but it began with a beat. Now the problem is to sing a tone with the beat, hold it while the second beat is given, and have it followed by a short tone before the next following beat occurs. In order to do this, the pupils must have a strong feeling for the beat of the measure. This they will have if the rhythm work has been properly done in the preceding grades. In first presenting this problem, let the class observe, by listening, the movement in, say, the second measure of the tune *America*, or any other tune which contains this problem. It may be necessary to have them clap the measure. Persist in it until they hear that after-beat tone. When they have felt this rhythm in a song, show them how the technical point is developed by means of the following:

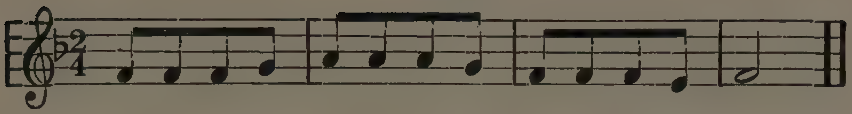
Teacher sings with la.



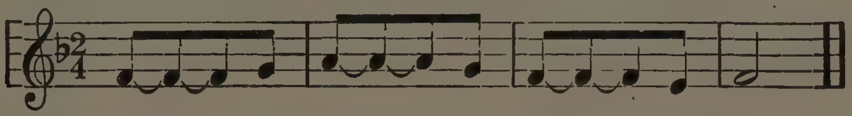
She asks the class to sing it back to her with syllables, and then has someone write it on the board with correct meter signature, bars in the right place, and notes of the right kind.

Keeping the same tempo, the teacher then sings, and has the pupils write:

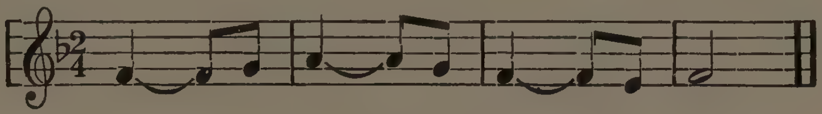
B



She then sings Exercise B again, this time tying the first three notes in each measure. The pupils know the use of the tie, and with a little questioning will write this:

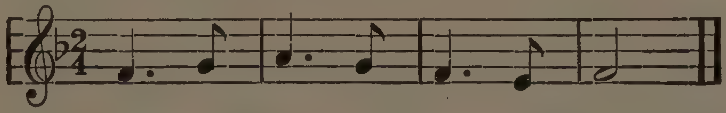


Then ask for a different way to represent the same thing. It might be represented this way,



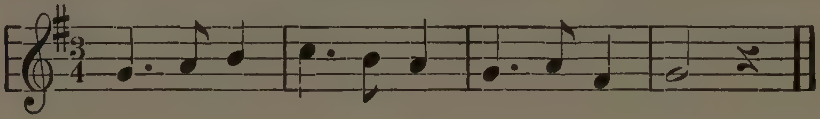
and it is well to have the pupils write it so.

But there is another and simpler way. We have a quarter note and an eighth note tied together. The time value of an eighth note is just half that of a quarter note. We have learned before, that if we want to add to a note one-half its original value, all that is necessary is to put a dot after it; so the pupil writes:

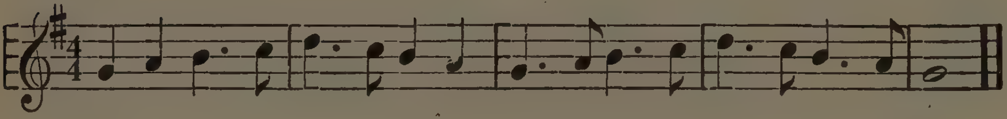


Have the pupils write the first two measures of *America*, or any other tune with which they are familiar and in which the problem ♩. ♪ occurs. After this, have them read a number of songs, or exercises, containing the same principle. The advantage in using exercises is that many short examples may be given. If songs are used, do not stop to have them finished for artistic singing, but read several, one after another. After the rhythmic principle has been fixed by a number of applications, the songs may be taken up for further study and polish. In these first applications, try to find exercises and songs that are simple in tune, that is, that contain no very difficult skips and no chromatics.

The principle once mastered, there is little difficulty in applying it to different kinds of measures, but it is well to dictate exercises in three-four and six-part measure, as,



and



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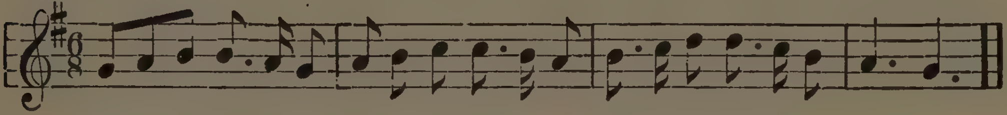
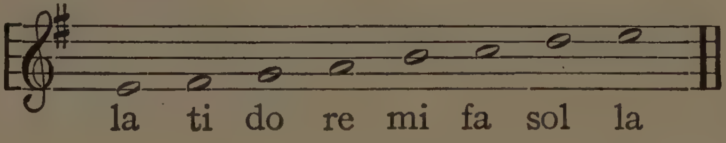
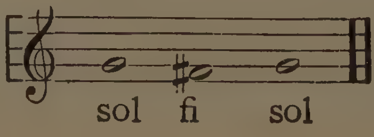


7. Tone. By the end of the third year, the pupils should have practically mastered the tones of the major diatonic scale. They should be able to read and sing any ordinary skip not involving chromatic tones. In the third year they have had presented sharp-four, and possibly flat-seven, so that they have a partial familiarity with these chromatic tones. They have learned, by rote, songs in the minor mode, so that the minor effect is not unfamiliar to their ears. They may have sung as a tone drill, without explanation of the mode, this exercise:

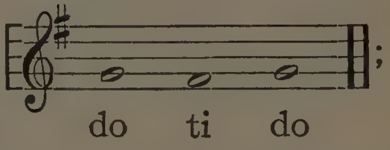


In the fourth year, the work in chromatics advances, and the minor mode is introduced.

8. Chromatics. To lead to the easy mastery of chromatic tones, take each tone in such combination with other tones as will be found in ordinary melodies; then, by comparison, present this same combination of tones in a key which will not require the use of chromatics to make the same tune. This will be clearer, if illustrated. The most commonly used chromatic is sharp four, called fi (fe). The combination sol fi sol in the key of C is written thus:



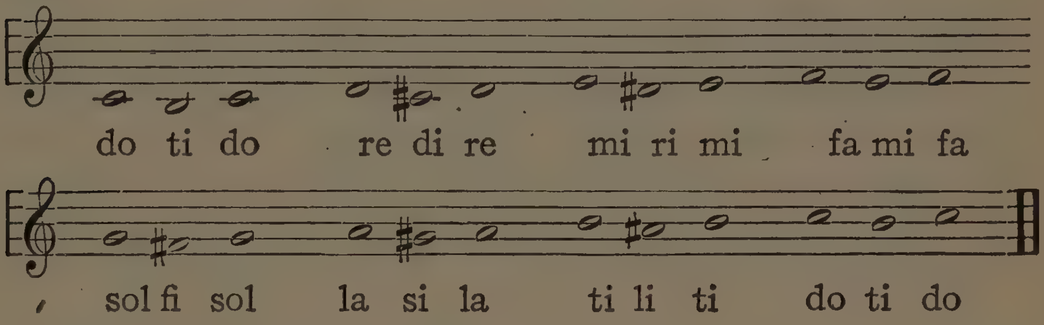
and the pitch names are g, f-sharp, g. Now if we write g, f-sharp, g, in the key of G, we have



which sounds exactly like sol, fi, sol, in the key of C, and can be used as a pattern for sol fi sol.

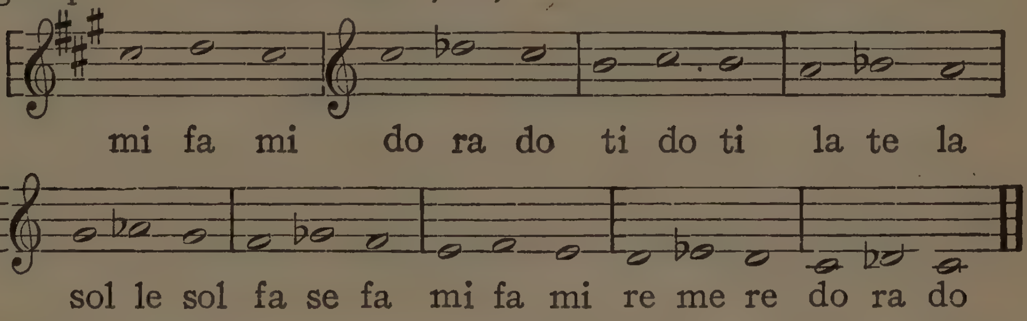
It is not possible, without occupying extended space, to give the various combinations. The best guide for the development of chromatics is found in the *Natural Music Charts*, which may be obtained in pamphlet form. Do ti do is a pattern for re di re, mi re mi, sol fi sol, la si la, and ti li ti.

The ascending chromatic scale is easily sung in the following form:

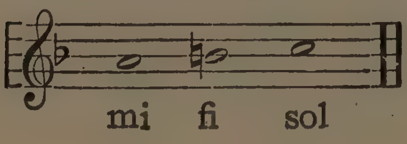


Each group has the effect of do ti do.

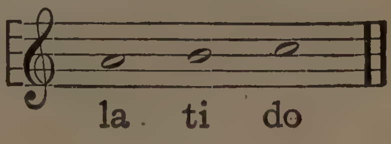
Mi fa mi can be taken as a pattern for do ra do and other groups of the same kind; as,



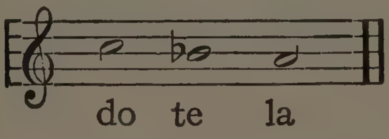
The sharp four approached from below is one of the early combinations studied. The combination



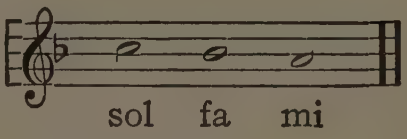
is in effect like



Flat-seven is commonly used, and is taught by comparison with sol fa me; thus:

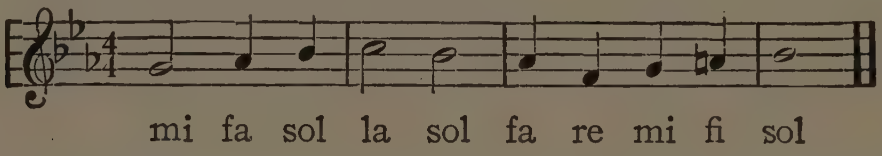


is like

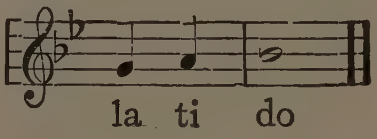


Each teacher can work out the problems for herself as they appear in the material she is using, if she has a good knowledge of keys; and a little of this practice will increase her knowledge.

For instance, suppose the song is the familiar *Abide with Me*, in which this passage occurs:



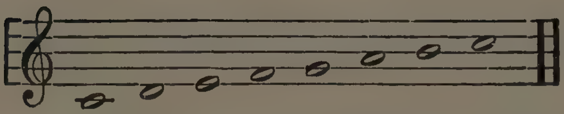
If the pupils have trouble singing mi fi sol, let them change mi to la, and sing:



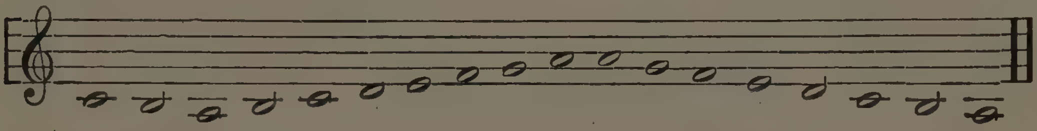
When the tune is fixed, they can sing it with correct syllables in the key in which it is written. In this way most chromatic combinations can be worked out. Remember, however, that the end to be gained is to make the pupil so familiar with each chromatic tone that the device described will become unnecessary.

In every well graded course there are certain exercises and songs containing chromatics, which may be used for drill in securing pure intonation. The chromatic scale as a whole need not be attempted in this grade.

9. Minor Mode. In the third grade the pupils have become familiar with the minor effect in songs and tone drill. In the fourth grade they should learn the theoretical construction of the natural minor scale. As an introduction to this scale, have the class sing the major scale from do to do, in the key of C, for example. A higher pitch is better for the voices, but key of C is the best model.

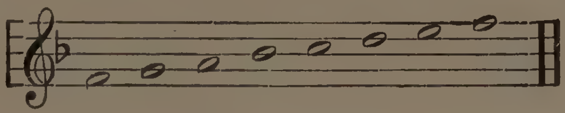


Have them sing to la below lower do, then up from la to la above; thus,

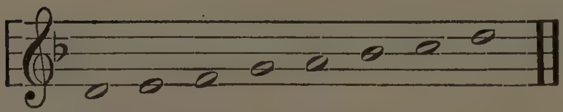


Explain that every major key has its relative minor key, which is a third below, or on la of the major. Explain further that the major scale and its relative minor have the same key signature. The major scale begins on do, while the minor begins on la. The rule for finding do from the key signature is still applicable only from this point, or pupils must look to the end of the exercise, or song, to determine the key. If it is major, it usually ends on do, and takes its name from the letter on which do occurs. If minor, it ends on la, and then it takes its name from the letter on which la is found. In the example given, the keys are C major and A minor. It is well always to use the terms *major* and *minor* in naming the keys. The form taught in this grade is the natural, or normal, minor, by some called the *old minor*. It uses the same tones as the major scale, but begins and ends on la; in other words, it is written without chromatic signs. After explaining the formation of the relative minor scale, have the class work out two or three scales by following the teacher's questioning and direction, the teacher writing the scales on the board.

Example: The teacher writes:



asking the class in what key this scale is written. They answer, "The key of F major." The teacher then asks, "Where is la in the key of F major?" The pupils reply: "On D." Then the relative minor scale of F major is D minor, written thus:



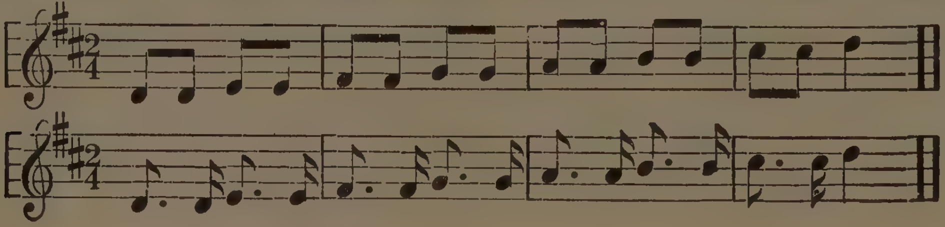
For practice, have the class write in their note books all the major scales, with their relative minors.

10. Tonic Chord. Drill the class in singing the tonic chord of the minor key—la do mi la—and when starting a song, or exercise, in a minor key, establish the key by singing the triad la do mi, if necessary, as you have sung do mi sol to establish the major key. This plan, pursued for a little time, will make the minor work very simple. In the dictation exercises give some very simple minor melodies.

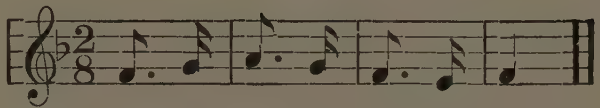
11. Part Singing. Two-part songs and exercises should be used in this grade, but not exclusively. Pupils should not be allowed to sing the same part all the time. They all need the practice of singing each part, so the division may be made by classes, or rows, and the different divisions should change parts. Rounds and canons furnish good material for part singing here. Much unison material should be used, as it tends to preserve the voices, cultivate flexibility and increase the compass.

FIFTH GRADE

12. Rhythm. Following the usual plan, the rhythmic problem of the fifth grade is the unevenly divided beat, which may be represented thus: $\frac{2}{4}$ ♪. 𝅘𝅥𝅯 ♪. 𝅘𝅥𝅯. This is taught very easily by rote, by comparing it with the evenly divided beat. The teacher may place upon the board an exercise like this: $\frac{2}{4}$ ♪ ♪ ♪ ♪, which may be sung on one tone, or with a simple tune; then directly under it write and sing $\frac{2}{4}$ ♪. 𝅘𝅥𝅯 ♪. 𝅘𝅥𝅯, contrasting the two movements—the two tones of equal length, and the tones of unequal length.



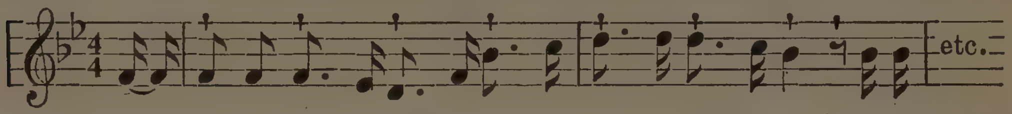
Another drill which can be used is to write an exercise like this:



First have the pupils sing, giving two beats to a measure, as it is written. After getting the swing, or movement, keep the same movement, but give only one beat to a measure. Then erase the bar and change the meter signature to $\frac{2}{4}$.

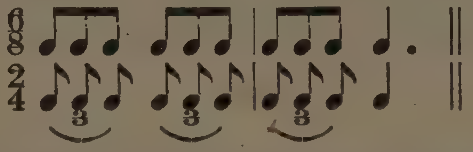
The same problem should be worked out in the different kinds of measure and by means of dictation exercises.

An excellent device for making pupils exact in time is to have them mark the notes on which the beat occurs; for example, take the first two measures of *The Battle Hymn of the Republic:*



and with some kind of a mark, possibly just a dot, indicate where the beat comes. Remember this is simply a device and should be used only when needed.

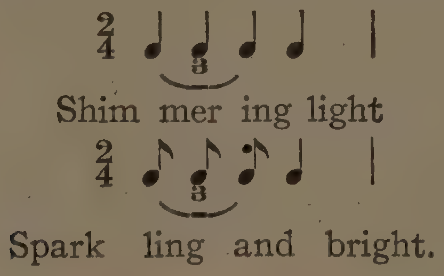
If the triplet has not been introduced before, it should come in this grade. It can be presented by comparison with $\frac{6}{8}$ meter when given with just two beats to a measure.



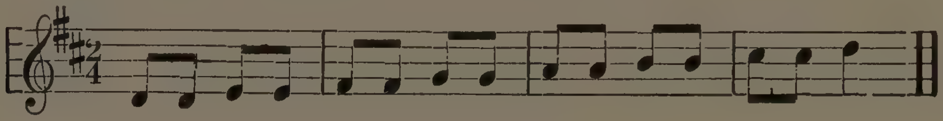
Another excellent plan for its presentation is to have the class read the following words:

Shimmering light
Sparkling and bright,

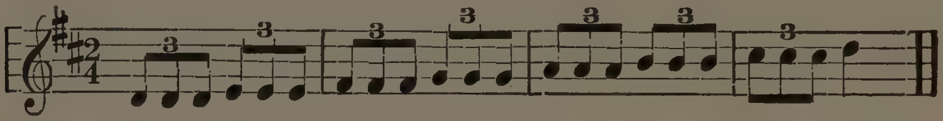
letting the accent fall as it naturally will, and represent it by notes as follows:



Four tones to a beat are easily mastered as a doubling up of two tones. A good drill for the equally divided beat is to sing the scale with two tones to a beat, three tones to a beat, and four tones to a beat. This can be done in two different ways, as follows:



and down with the same movement, then



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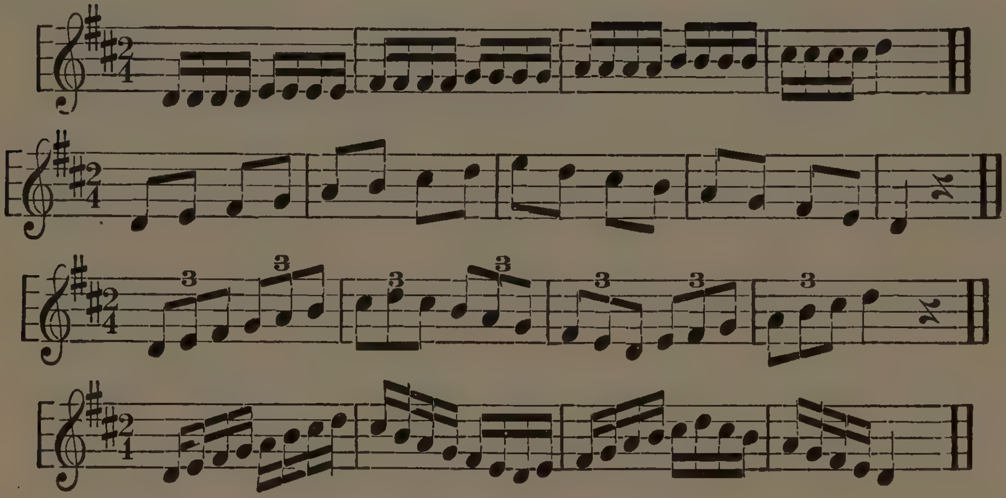


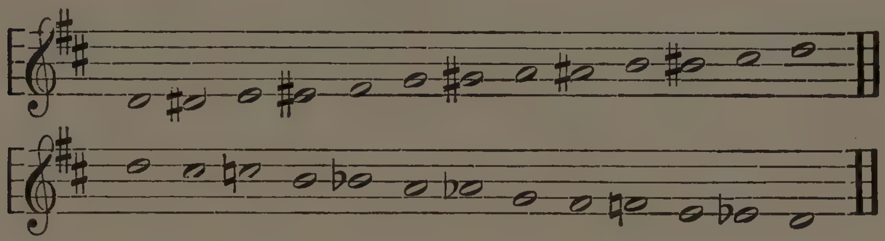
13. Chromatics. The work in chromatics in this grade is merely a progression to more difficult combinations, which can be simplified in the manner described in fourth grade. Pupils who have had thorough drill on sharp-four and flat-seven seldom have difficulty in singing the other chromatic tones.

Drill on the entire chromatic scale will help to secure correct intonation. To accomplish this object, an almost constant use of the pitch pipe is necessary. In the beginning it will be necessary to sound the pitch on several different tones of the scale. After some practice, it may be sufficient to test only on the last tone. Careful observation will show the teacher on which tones the class is likely to be untrue.

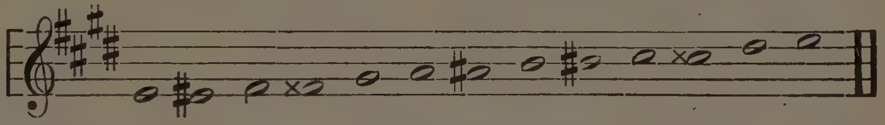
The chromatic scale can be written in any key. The syllables for the ascending scale are do, di,[1] re, ri, mi, fa, fi, sol, si, la, li, ti, do.[1]

Descending: do, ti, re, la, le, sol, se, fa, mi, me, re, ra, do.

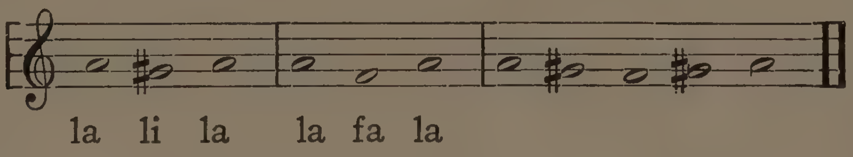
In the key of D the scale is written as follows:

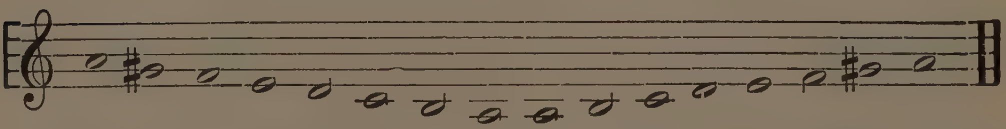


Observe the scale is 1, ♯1; 2, ♯2; 3; 4, ♯4; 5, ♯5; 6, ♯6; 7; 8. And, 8; 7, ♭7; 6, ♭6; 5, ♭5; 4; 3, ♭3; 2, ♭2; 1, and in writing keep in mind what letters are sharped or flatted in the signature. In some cases it is necessary to use a double flat (♭♭) or double sharp (×). For example, in the key of E,



14. Minor. Teach the harmonic minor scale. This form is written like the natural form, except that the seventh tone is sharped. The syllable names are, ascending, la, ti, do, re, mi, fa, si, la; descending, la, si, fa, mi, re, do, ti, la. The interval from fa to si is an augmented second, and is one with which the pupils are not familiar. As a preparation for singing the harmonic minor, let the class first sing the natural form, then use the following exercises:





Have the pupils write the major scales in all keys with the relative minor in harmonic form. Remember it is the seventh of the minor that is sharped.

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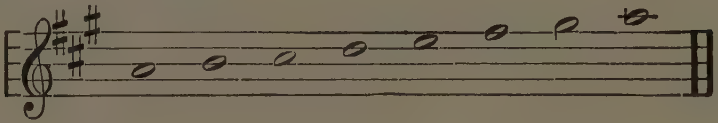
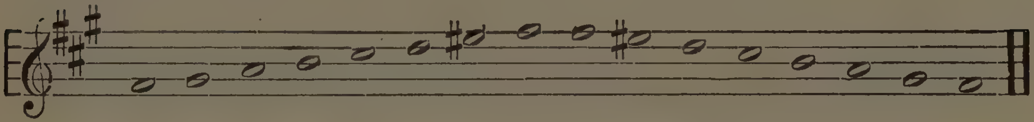
[1] *i* is pronounced like long *e*; *e* like long *a*, and *a* has the long Italian sound.

Example: A major



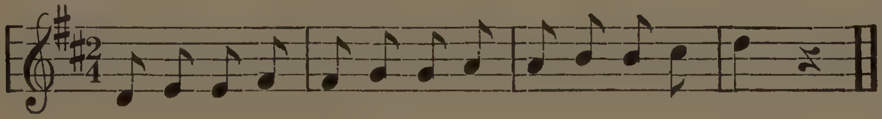
F-sharp minor



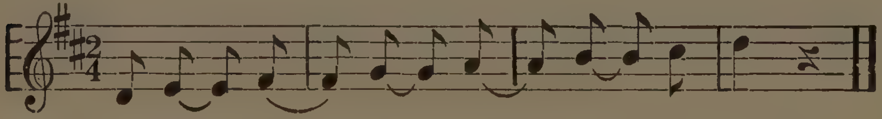
15. Part Singing. Three part music may be used in this grade, but not exclusively. There should be much practice in two parts and unison. Parts should be sung interchangeably.

SIXTH GRADE

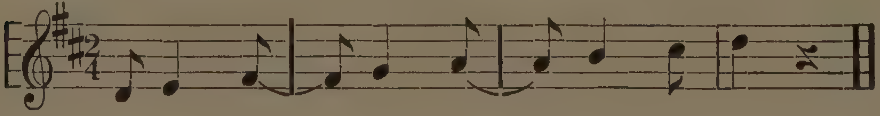
16. Rhythm. The rhythmic exercises in the grades, with one exception, are simply the application in different combinations of the principles already developed. The exception is syncopation. *Syncopation* is an interruption of the regular accent. It is produced by prolonging a tone, which begins as an unaccented beat, over the point where the strong accent should occur, thus throwing the strong accent out of its usual place. You will find not much application of this principle in music courses. For an exercise to illustrate it, take the scale in the following manner:



Then tie the notes as follows:



Then the same effect is represented as follows:



Be very careful to keep the beat even. At first it may be necessary to beat in some audible manner, but do not continue that practice.

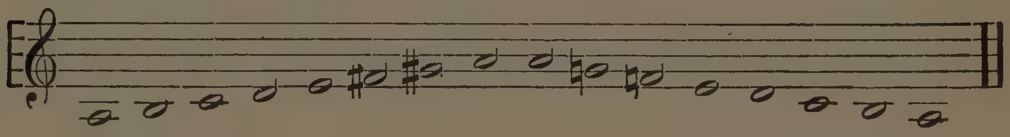
17. Chromatics. Chromatic work in this grade will consist of exercises and songs including chromatic tones in various combinations, which can be worked out, if necessary, according to the plan suggested in the fourth grade. Use that device only when the pupils have difficulty in singing the chromatic tones.

Drill on the chromatic scale occasionally, but not long at one time. Have the pupils write the chromatic scale in different keys. Give dictation exercises containing chromatic tones.

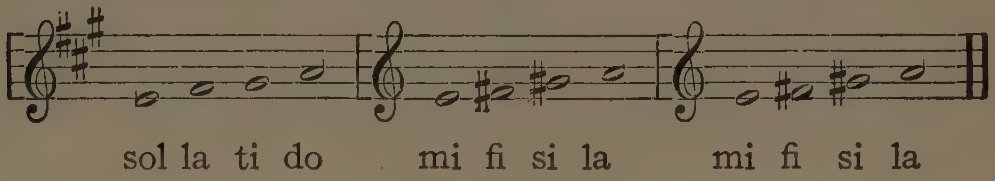
18. Minor. Review the natural and harmonic forms of the minor scale, and teach the melodic form.

In the melodic minor scale, the sixth and seventh tones are sharped in ascending, and made natural in descending. The syllable names, ascending, are, la, ti, do, re mi *fi si* la; descending, la *sol fa* mi re do ti la.

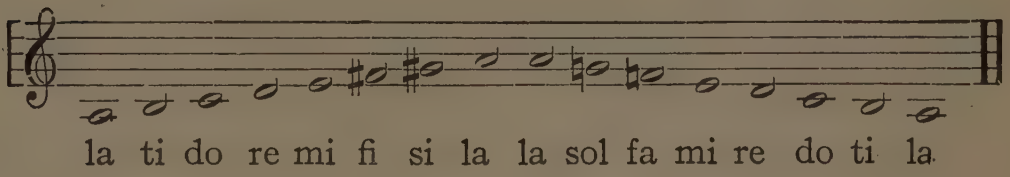
In the key of A minor it is written:



The difficulty in this scale is mi, fi, si, la. As a preparation have pupils sing sol la ti do, which sound the same; thus,

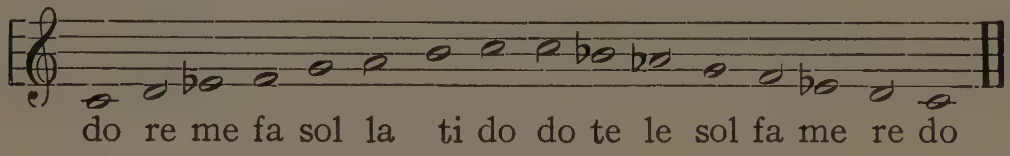


Then again,



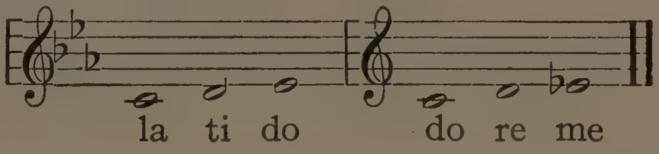
The descending scale in melodic form is just the same as in the natural form, with which the class is quite familiar.

There is one other minor form which may be taught here, as it is in effect like the melodic minor. It is called the tonic minor, and is formed on do of the major scale. It is written:

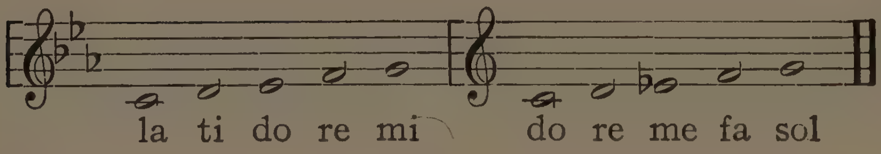


In the ascending scale the third is flatted. In the descending scale, the seventh, sixth and third are flatted. Have pupils write major scales with relative minor, melodic form, also the tonic minor melodic form. If there is trouble in singing the tonic form, have class practice the do re me by comparison with la ti do.

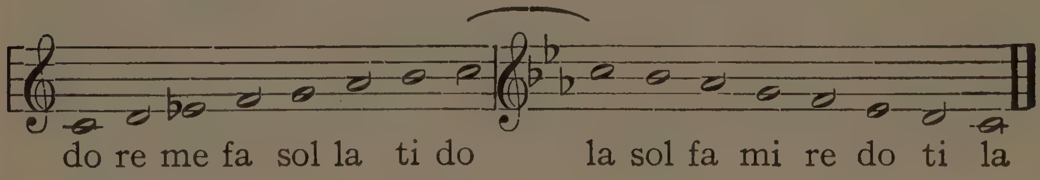
Thus,



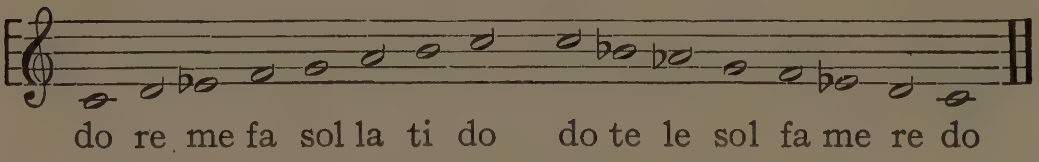
Then,

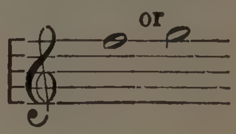


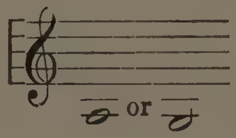
After which,



Then,



19. Part Singing. In the sixth grade the voices should be tested to determine for which parts they are best suited. Do not allow all the boys to sing alto, regardless of their voices. Many boys in sixth grade still have high soprano voices. Others can take second soprano, and still others the lowest part, or alto. Do not allow a girl with a high soprano voice to sing alto, just because she is musical and can carry the second part. Irreparable damage is sometimes done by this practice. The part a voice should sing is determined more by the quality of the voice than by the compass. If the quality is right, the compass will usually be developed by singing. Sopranos should be able to sing to 

Alto down to 

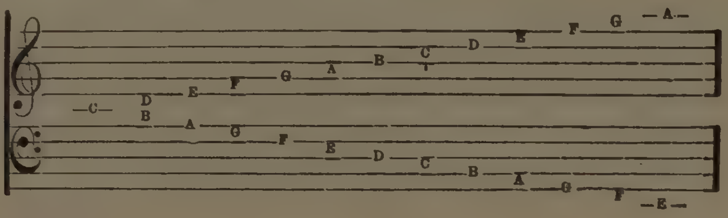
As a rule, there are no changed voices among the boys in this grade. Unison singing should continue.

SEVENTH AND EIGHTH GRADES

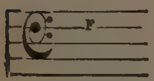
20. Aim. It should be the aim in the seventh and eighth grades to have the pupils become acquainted with as much good music as possible. In the six grades below, there have been presented to them practically all the technical principles necessary for reading music. From this point on, they should know and enjoy the best compositions that lie within the scope of their abilities.

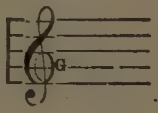
21. Review. Technical knowledge should be reviewed. This can best be done by means of written work. During each year have the pupils write the major scales, with their relative minors in different forms, and the chromatic scale in several different keys. Be sure that key signatures are well fixed, and meter signatures thoroughly understood. Pupils should be able to write from hearing simple melodies. A good drill for this purpose is to have them write tunes with which they are familiar. These are to be written from their memory of how the tune sounds, not how it looks on the page; in other words, not copied from the book. This is the best test of their knowledge of rhythm forms. If the class is found to be weak on any of these technical points, pursue the plan suggested for the first presentation and drills of the same principle. Bear in mind, however, that each reading lesson is practically an application, and the best application of many technical points.

22. Bass Clef. The voices of many of the boys will change in these grades, so that it is necessary to introduce the bass clef. To simplify this, explain the use of the clef signs and also the great staff. Show them that middle C belongs to both staves, as follows:



Reading in the bass clef is just the same as in the treble clef, once the position of do is fixed. This clef is called the *F clef* and shows that F is on the fourth line, just as the treble clef is called the *G clef* and fixes the position of G on the second line





Have pupils practice writing key signatures in both clefs; also have the entire school practice reading the bass. Some music courses give a number of unison exercises in the bass. If you do not find them in your books, have the entire school read the bass of some of the part songs, the girls, of course, singing an octave higher than the boys with changed voices.

23. Part Singing. Three-part songs and exercises should be used in seventh grade; three-part and four-part in eighth. Some unison singing should continue throughout both grades. Have the class read all parts together at the first reading of exercise or song. This saves time, gives them a better feeling for the harmony, and is what they will have to do if they enter a choir or choral society. If there are certain particularly difficult places for any one part, have that portion sung alone by those carrying that part, or have the entire chorus read the difficult portion.

GENERAL SUGGESTIONS

24. Sight Reading. Sight reading is not an end, but a means to an end. As stated at the beginning of the chapter, we first learn to read, and then read to learn. It is as necessary to the full enjoyment and understanding of music that one be able to interpret the printed symbols easily and readily as it is to be able to read English in order to enjoy literature. Reading should be an interpretation, and not a mere calling of tones. As in English, so in music one learns to read by reading. In selecting material, choose books that will give you an abundance of simple work in the beginning, and that present for each grade many songs and exercises that are simple for that grade. New technical principles, with their applications, must come in each grade, but if all the material is of the highest grade of difficulty there is too much plodding and the spirit of the music is sacrificed. There should be some reading of new material every day. Cultivate the habit of reading the exercise correctly the first time. To do this, it is well to have the class understand that they will have only one trial. Read straight ahead a number of exercises or songs, even if they are not read with perfect accuracy. After covering two or three pages in this way, go back and read again those which were not perfectly rendered. If in the material so read there is a song which is attractive, take it up at the beginning of the next lesson and read it again. You will find that the second reading is much easier than the first, particularly if in the meantime something more difficult has been attempted. Two or three readings in this manner will bring mastery of the technical part of it, and then further time should be given to artistic interpretation and finish. Reading through to the end of a selection is also a matter of habit. Some schools have the habit of reading a measure or two, and then going back to the beginning. The second time they read a measure or two farther and then stop, and so on until finally they plod through the entire exercise. They should, the first time through, grasp the composer's idea, even if they miss some of the niceties of his expression; that can come in a second reading.

25. Interval Drill. With plenty of material for practice in sight reading, there is little need for so-called interval drill. Just before taking up a new song, or a series of exercises, a quick drill may be given to help the pupils locate the tones in that particular key. To do this, the teacher writes the notes on the staff, the pupils responding with the tones by syllables as fast as the teacher writes. If there is a particularly difficult interval, give special attention to it by repeating it several times in the drill. The entire drill should not take more than two or three minutes.

26. Interpretation. It is not possible to make too strong a plea for the interpretation of the songs. This is commonly called singing with expression. Any teacher who can bring out expression in the reading of a poem, or a beautiful bit of prose, can, by the same means, call forth an expressive rendering of a song. The difference between artistic singing and mechanical vocalizing, be it ever so correct, lies in the artist's ability to feel and express what the poet says. The composer emphasizes and embellishes what the poet expresses in words. The signs *forte* and *piano*, *crescendo* and *diminuendo*, *accelerando* and *retard*, are but the composer's suggestions, and are unnecessary to the person who reads the poem understandingly. More than that, they usually fit only the first stanza, and the other stanzas may call for quite a different rendering.

A few rules to bear in mind are the following:

(1) Enunciate clearly and distinctly.

(2) Dwell on the vowel sounds.

(3) Where a word is held for a long tone, hold it on the vowel, and pronounce the final consonants just at the end of the tone.

(4) Phrase the singing as you would phrase the reading of the poem.

(5) Do not breathe between the syllables of a word.

(6) Do not breathe between a preposition and its object.

(7) Do not breathe between a verb and its object.

(8) Careful attention to correct phrasing will give the desired breath control.

27. Voice. It is not the province of public schools to give lessons in so-called vocal culture. It should be the province of the teacher to preserve the voices and cultivate good habits of vocalizing.

By some, soft singing is considered a panacea for all vocal ills; but there are several other rules to be observed:

(1) Do not, on any account or at any time, allow hard, harsh singing. Some songs require more volume of tone than others. This is a matter that should be regulated by the interpretation of the song.

(2) Keep the pitch high, and ask for a clear, light, sweet tone.

(3) Practice singing the descending scale. Also practice singing sustained tones.

(4) Have much unison singing throughout the grades.

(5) Do not let pupils below sixth grade sing any one part exclusively, unless the voice is an exceptional one.

(6) Continue unison singing throughout all grades. Every well arranged graded course provides unison songs and exercises, even in the eighth grade.

Caution. Be sure that those few simple rules are followed at all times. Do not ever accept a harsh, loud tone, no matter if the exercise is simply an interval drill. Insistance on good tone always will do more than the practice of many vocal drills.

28. Written Work. "Writing maketh an exact man." Two of the chief benefits derived from written work are accuracy and self-reliance. In the foregoing lessons are given suggesions for the writing of scales. It is a good plan to have the pupils use note books which are ruled for music writing. In these they can write their scales, and keep them for future reference.

29. Dictation. In Section 1 it is stated that the processes in learning music are imitation, recognition, representation and interpretation. Dictation involves two of these, namely, recognition and representation. In dictation, the teacher sings, or plays, a tune; it may be a very small one, and the pupils write what they hear. This exercise serves several purposes. It can be used for the first presentation of technical points as they appear in the development of the subject. This use is set forth in detail in the fourth grade outline (Sections 6-11), and the same general plan can be pursued in all succeeding lessons. For the first presentation of a technical principle, the exercise should be simple in all other respects, so that the attention can be centered upon the one new principle. The same is true of the drill exercises which should follow the presentation, in order to make this new principle and its representation a part of the pupil's working knowledge.

Besides this use for the presentation of new points, occasional dictation exercises will quicken the pupils' musical intelligence, make them better readers, and strengthen them in all lines. For this purpose, the exercises should be complete melodies that embody the various technical points presented up to that particular grade. In other words, the dictation exercises should be similar in construction to the exercises then being read by the class. If the teacher cannot make her own melodies for this purpose, she can select phrases from the exercises and songs in the text-book in use, being careful to select those which the pupils have not memorized. Sometimes it is a good plan to select phrases from the material which is to be used for sight reading practice in the same lesson, using it first for dictation and afterwards for reading. Another valuable exercise is to have pupils write complete tunes which they have learned by ear.

The third use for dictation is as a test of technical knowledge. For instance, instead of asking the pupils, "What is the signature for the key of E," or, "How many quarter notes to a beat in $\frac{3}{4}$ measure," sing a melody in 3-part measure, including in some portions two tones to a beat. Ask the pupils to write this melody in the key of E. If they write it correctly, they have given the best answers to the questions.

30. Rhythm. A great deal is said and written about rhythm exercises, but a few simple rules, faithfully observed, are better than many rhythm drills. In the first place, take every selection, be it exercise or song, in good tempo; do not drag. Then observe the accent. Remember that rhythm is "measured flow." Let the music move along, and its movement be measured by the accent. It is the accent that makes the measure, and the bar across the staff simply shows where the accent should occur. Insist that the singing be done so that a person listening, but not seeing the notes, could tell in what kind of measure the selection is written. Be sure that the pupils *feel* the measure, and that they give to each note its exact value, and rhythm will take care of itself.

31. Individual Work. Have each pupil read an exercise, or part of a song, alone, once a week if possible. This can easily be done in the lower grades, and the pupils of the upper grades will not object if you make them feel that music is just like other studies, such as reading, arithmetic and geography. Each one is expected to do the best he can. This practice, together with the written work, will make each member of the class independent.

32. Use of Pitch Pipe. Never trust to your own voice or that of a pupil to pitch the songs or exercises; always use the pitch pipe. Use it at the beginning to establish the pitch, and use it at the end to see if the true pitch has been kept. Sometimes you can overcome the habit of flatting by this simple means.[1]

33. Original Composition. Unless you yourself are familiar with the rules for melody writing, and feel perfectly competent to lead the pupils into correct musical expression, do not attempt original composition.

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[1] The Congdon Pitch Pipe gives the key note for ten tunes. It can be obtained of C. H. Congdon, 629 S. Wabash Ave., Chicago. This little device is inexpensive and is often of great assistance.

34. Definitions and Terminology. It is beyond the scope of this chapter to give definitions of words and terms used in music. A word of caution may be offered: Be careful to use exact terms. Webster's *International Dictionary* will give you the correct definition and use of nearly every term to be found in your music texts. Use the dictionary.

35. The Recitation. There is no other lesson in which absolute attention and concentration of all powers of the mind are more necessary than in music. In fact, this is one of its chief educational values. Bring to this recitation all the enthusiasm you have, and make it one of the happiest periods of the day. Demand and keep the entire attention of the class. Have an objective point in every lesson. Plan the lesson so that every minute shall be used to advantage. Do not dwell too long on one exercise or drill. All principles of pedagogy that you use in other subjects will apply to music.

Keep the work moving; let pupils feel that they are progressing, and they will always be interested.

TEST QUESTIONS

1. What ground should be covered in the first three grades?

2. What technical points should be developed in fourth grade?

3. What technical point developed in fifth grade. Give an exercise of your own for developing the harmonic minor scale.

4. What technical points are developed in sixth grade? Give an exercise for developing the melodic minor scale.

5. What two methods are suggested?

6. How would you develop the ♩. ♪? The triplet?

7. What plan may be used to simplify the reading of chromatics? What is the pattern for la si do?

8. How would you develop rapid and independent reading? How would you secure correct and artistic interpretation?

9. What is dictation? Of what value is it?

10. Give rules for the preservation of voices.

CHAPTER TEN

ADOLESCENCE

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CHILDHOOD

1. Divisions of the School Period. The school period, extending from the time the child enters the primary grade until he completes the work of the high school, is usually divided into four divisions: primary, intermediate, grammar and high school. Development during the divisions covered by primary and intermediate grades consists largely in growth; first, in size, and secondly, in the perfecting of the organs. As the child completes the work of the intermediate grades, he enters upon the radical change which accompanies the dawn of adolescence.

2. General Characteristics. That division of the school period extending through the primary and intermediate grades may be divided for convenient study into two subdivisions, the first extending to the age of eight, and the second from the eighth to the twelfth years.

By the time the child reaches the age of six he has, in a great measure, outgrown the apparent aimless restlessness which has been so prevalent in the years just preceding. Up to this time nearly all the child's activities have been for the satisfaction of his physical needs or the relief of the strain upon his system incidental to the rapid growth of the muscles and nerves. During the fourth and fifth years the capacity for power has gradually been assuming control, and the impulsive stage of early childhood merges into the stage upon which the child enters in the sixth year, and in which acts are put forth for more definite purposes and for the satisfaction of desires that pertain to the mental as well as the physical welfare. Many of these activities are prolonged to the limit of the child's strength, that the desired end may be reached. There is also a broadening of interests and strengthening of the mental powers; perception is remarkably keen, but since the reasoning powers are still weak, nice discriminations cannot be made.

When he enters upon his eighth year a perceptible change occurs and a new era seems to dawn in the child's life. Concerning this period an eminent authority says:

> The years from eight to twelve constitute a unique period of human life. The acute stage of teething is passing, the brain has acquired nearly its adult size and weight, health is almost at its best, activity is greater and more varied than ever before or than it ever will be again, and there is peculiar endurance, vitality and resistance to fatigue. The child develops a life of its own outside the home circle; its own interests are never so independent of adult influence. Perception is very acute and there is great immunity to exposure, danger, accidents as well as to temptation. Reason, true morality, religion, sympathy, love and aesthetic enjoyment are but very slightly developed.[1]

We should not infer from the above statement, however, that these changes take place suddenly and without warning. The child has been approaching this new manifestation of development during the years just preceding, and the changes are usually so gradual that those in daily association with him do not realize them. While the eighth year is the one generally given as the time for these changes to become manifest, the time varies with the individual. During each of these stages the child should receive the care and instruction especially suited to his needs.

3. Muscular Activity. When the child enters school, only the larger muscles — those which move the arms, legs, trunk and head — have reached a stage of development which enables them to perform their functions with a reasonable degree of accuracy. Control over the smaller, or *accessory muscles*, as they are sometimes called, develops later. These small muscles preside over the more intricate movements of the hand, tongue, face and vocal organs. They are used in those acts requiring finger movements, as in writing, sewing and playing the piano; in speech, and in those facial movements that give a great variety of expressions of which only the human face is capable. These muscles are connected into an extended series, and the activity of one set usually induces activity in one or more of the other sets. Facial expression accompanies conversation, and any intricate work of the hand is liable to cause a peculiar, though unconscious, contractility of the facial muscles, and so on. Furthermore, the action of these muscles is associated chiefly with mental activity. It is their function to give expression to thought and feeling.

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[1] G. Stanley Hall *Adolescence.*

In the Chapter XI, *Psychology*, we show the difference between growth and development in the brain. This distinction applies to the muscular as well as to the nervous system, and nowhere is it more clearly seen than in the contrast in development between the large and the small muscles. The delicate structure, as well as the nicety of functions of these accessory muscles, at once show that their action depends upon the development of the associative fibers in the nervous system as well as upon the growth of the muscles themselves. Therefore it is possible that these muscles do not reach their normal degree of activity until some time after the large muscles have attained their full development.

A knowledge of these facts is of great importance to both parents and teachers, for without such knowledge they are liable to require of children tasks for which their muscular systems are in no wise prepared. Writing, drawing and all those tasks which require finger movements, and vocal exercises which overtax the muscles of articulation, are of this nature. In the primary grades, especially the first and second, exercises of this sort should be limited in number and the periods devoted to them should be short. But writing and drawing on the blackboard when the arm movement is used is recommended.

Overtaxing these muscles at this time not only causes fatigue and irritation, but it is also liable to induce partial paralysis, which will prevent those muscles suffering the severest strain from ever reaching their full development. Doubtless many persons have had their usefulness sadly curtailed by the overstimulation of the accessory muscles during the first years of school life.

By the eighth year the accessory muscles begin to respond more readily to stimuli, and from this time through the tenth year movements improve in accuracy more rapidly than at any other period, and at adolescence the adjustment of large to small muscles is practically established. From this it follows that exercises requiring the use of these muscles can be increased in number and length to the advantage of the pupils, provided always that the gradation is not too rapid.

From eight to twelve the child is remarkably active, and during this time he should learn and make automatic all those movements essential to his daily welfare, and he should add to these the mechanical features connected with writing, figuring and drawing. If pupils can still add the muscular training acquired through the use of common tools for boys, such as the jack-knife, hammer, saw, ax and plane, and for girls the scissors, the needle and the common household utensils, all the better. This is particularly the habit-forming period of life and it is the teacher's duty to see that her pupils make automatic as many useful acts as possible.

4. Value of Muscular Training. Thought finds expression only through muscular action, therefore in training the muscles we are in one sense, training the mind. While muscular training should begin early, it should proceed gradually. As each group of muscles arrives at its stage of activity, it is necessary that the action of these muscles be brought under control and that they have their movements organized and often related to those of other groups.

Often inhibition is the most difficult task imposed upon the child. This is particularly noticeable in the efforts of a young child to sit still. He will hold his breath, set his teeth, clench his fists and make every muscle in his body tense, and the effort is so great that his strength is soon exhausted. Children in primary grades therefore need frequent exercises to relieve the large muscles from the stress arising from inhibiting their movements. Light gymnastics, marching, a quiet run around the room now and then between recitations, answer the purpose and more than compensate for the time taken by keeping the children in such condition that they can do vigorous work throughout the entire session. While these exercises relieve the muscles of a portion of their stored-up energy, they accomplish little toward muscular development. For this, abundant exercise in the open air is necessary.

Whatever occupation one may follow, an all-round muscular development is essential to health and the highest degree of skill as well. We are aware that the brain contains centers from which proceed nerves of various functions, and that these centers are connected by associative fibers. Neurones which control the movements of muscles are found to some extent in all of the sense areas and the purely motor areas are larger than those presiding over any other function. These motor areas are composed of units within units, or centers within centers, as the motor area of the arm includes the areas controlling the movements of the hand and the fingers; or the motor area of the leg includes the areas which control the movements of the foot and the toes. (See *Psychology*, page 320).

Associative fibers join the various motor areas so that the activity of one stimulates to a greater or less degree the centers most closely associated with it. The more completely all of these centers are developed, the less the danger from a high degree of specialization, or the extraordinary development of a single center or group of closely related centers by following some occupation which constantly requires the use of one set of muscles. It would seem that the blacksmith, by constant use of his right arm, would develop the motor areas which control the muscles of the arm to a much greater degree than does the watchmaker or the shoemaker. If all these related centers are fully developed, those not directly employed will discharge a portion of their nervous force to the centers which become exhausted from prolonged stimulation. The smith having the motor centers of both arms fully developed does not suffer from muscular fatigue so soon as his co-laborer who has never given any special attention to the development of his left arm.

This illustration applies with equal force to all specialized activities. In a like manner we might infer that one who devotes himself to mental work can work longer and more effectively if his motor areas are strongly active. Muscular training contributes both directly and indirectly to intellectual development and constitutes an important part of the child's education.

Before twelve, the out-going nerve impulses should have formed well-established paths. In other words, they should be developed into many more or less firmly fixed habits of action. Those movements requiring exactness and grace, such as writing, drawing, piano-playing, dancing, singing, pronunciation of foreign words and numerous other of the so-called accomplishments, must be well begun before the relative arrest of accessory growth at the dawn of adolescent regeneration and before its great inflowing of strength takes place.[1]

5. Intellectual Training. In Chapter XI, devoted to the development of the mental activities, the sorts of exercises best suited to the training of these functions are given at some length, and their repetition here is unnecessary. We should consider briefly, however, the nature of the school work best suited to the primary and intermediate grades. This is preëminently the *doing age* of the child. He gains knowledge of material things, memorizes facts and language with extraordinary rapidity. He learns to perform readily all tasks within his capacity, and acquires activities which are to help or hinder him in all his after years.

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[1] Adapted from G. Stanley Hall's *Youth: Its Education, Regimen and Hygiene.*

He can not at this time analyze complex problems, comprehend abstract truths, nor make nice discriminations. Observation, memory and imagination, which are growing rapidly and are in a state of intense activity, are the mental functions that should receive the greatest amount of attention in these grades. Because of the activity of these functions at this period, some educators have fallen into the error of supposing that they reach the height of their activity at this time, and have characterized the period as the "golden age of memory." The facts are that these functions increase in strength from year to year. The point to which we wish to call special attention is that at this time these functions are more active than others which develop later, and this is why they should receive special attention in the intermediate grades.

The elementary facts of number should be thoroughly learned, and the fundamental processes of arithmetic should be so firmly fixed that they become habituated. Language forms must also receive like treatment in order that their correct use may become habitual and spontaneous. Children who leave the intermediate grades without correcting their bad habits of speech seldom overcome the defect. Facts of history, geography and science which will be most useful to the child should also be learned.

That these things may be done, a great amount of drill work is necessary. Positive and direct instruction is also occasionally of great value. As we have already said, children like those exercises which involve rapid movement, provided they do not continue beyond the point of fatigue.

Long explanations of arithmetical processes, analyses of complex problems or of long sentences in grammar are not suited to the pupils' stage of development, and time spent on this sort of work is usually worse than wasted. Such exercises should be left until the pupils are more mature.

6. Children's Faults. Normal children outgrow most of the faults so common in the primary grades, but there are others which extend to the intermediate and grammar grades and which will need the attention of the teacher if they are to be eradicated. Chief among these are:

(a) RESTLESSNESS. With most children restlessness is due to physical causes which bring upon the nervous and muscular systems, strains that result in irritation. Confinement for too long a time in one position, uncomfortable seats, foul air, and scolding and nagging are the most common causes of restlessness among pupils. Children of a peculiarly sensitive nervous temperament are usually more restless than others. The remedy for this fault in the school is so evident that it needs only to be mentioned; that is, remove the causes. Be cheerful, keep the room well ventilated and the pupils comfortable.

(b) INATTENTION. Inattention is due chiefly to two causes: the child's inability to control his intellectual powers and the nature of the subject matter to which he is required to give attention. Too often this is unrelated to his experience and not infrequently beyond his mental capacity. Uninteresting lessons make inattentive pupils, and any exercise prolonged beyond the point of fatigue fails to receive due attention because of the physical condition of the pupils.

(c) LYING. Parents and teachers should make careful discrimination between falsehoods and false statements. The former are due to a deliberate purpose to deceive, while in most cases the latter are due to a vivid imagination which has developed far in advance of the reasoning function and is not under control. In most cases this fault will be outgrown. Sometimes greatly exaggerated statements need no attention and at other times they should be corrected. The treatment which they should receive must rest almost entirely with the good judgment of the parent or teacher.

While the teacher should make a distinction between a falsehood and a false statement, for the child's own good she should hold him accountable for falsehood. The remedy for this fault, however, does not lie in harsh treatment. The teacher should learn the causes of the falsehood and aid the child to overcome the difficulty. The two most common causes of lying among children are fear, and the influence of the child's environment outside the school. A child in whose home deception is practiced will naturally attempt to deceive, and his first discovery that such a course is wrong may come as a surprise. Under such conditions harsh treatment only intensifies the evil. The child must undergo a prolonged and severe struggle before he can overcome the bad habit into which he has fallen, and if he is to succeed he must have the confidence and encouragement of his teacher.

Fear is probably the most prolific cause of lying among children. Here the instinct of self-preservation exerts a strong influence. The desire to escape the consequence of his act often prompts the child to lie. This tendency is increased by injustice, harshness and a general attitude of disbelief on the part of the teacher. A child will usually lie much more readily to a teacher whom he dislikes than to one whom he likes.

The teacher who understands these conditions and who is sympathetic, can do much toward correcting this fault, though in some instances she may never succeed in completely eradicating it. The following suggestions will be found helpful:

(1) Consider the child to be truthful; disbelieve only the lie that has been proved.

(2) Be kind and sympathetic. Lead the child to see and feel that telling falsehoods is wrong.

(3) Win the child's confidence and love, and so keep the demon of fear out of his life.

(4) Sooner or later the lie is usually discovered, and then the guilty party is placed in a much worse condition than he would be had he told the truth. Show the foolishness of lying and lead the children to see and feel its inevitable results.

(5) Assist all children to attain to a high sense of honor and integrity. The business of the world rests upon men's faith in each other.

7. Life with Nature. The child lives close to nature unless his environment precludes such a life.

"Nature answers all he asks;
Hand in hand with her he walks,
Face to face with her he talks;
Part and parcel of her joy."

He personifies animals, wild and domestic, develops remarkable fondness for pets, makes companions of his cat and dog, and, if not biased by the prejudice of his older associates, loves and approaches every living thing without fear. To him pets, flowers, fields, forests and sky speak a peculiar language, and unless the parent and teacher can hark back to this period in their own lives, they are unable fully to share the child's joys or to enter into full sympathy with his experiences. Children who are denied this sympathy are likely to keep their experiences to themselves and live much alone from nine to twelve.

8. Growth of Social Feelings. Previous to the ninth year the child is usually satisfied with one or two playmates; but from nine to twelve there is a rapid development of the social feelings. This development gives rise to the desire for more extended companionship, and the child craves the society of several of his own sex and age.

This desire finds expression in the coterie of bosom friends, the gang and the club, both of which are so prevalent between the ages of ten and fourteen. The bonfire, with its circle of kindred spirits; the cave with its password and dark plottings; the street corner and recruiting whistle, have almost irresistible fascination at this time. What one boy does not dare, the gang will attempt, and the composite conscience may fall far below that of the individual.[1]

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[1] Lamoreaux: *The Unfolding Life.*

Investigation of these organizations shows that girls take more kindly than boys to organizations formed for them or suggested by adults, and that they also follow more closely the plan and purpose of similar adult organizations. Unless skilfully directed by someone who can gain the confidence of their members, these organizations among boys are more likely to be injurious than beneficial.

Boys and girls are bound to gather in groups, and under proper guidance these gatherings are for their interest. Parents and teachers should therefore recognize the craving for this broader social life and make provision for such organizations as will satisfy this demand under wholesome conditions. The home, especially, can exert a powerful influence in directing this social development aright. These organizations are held together by a certain degree of loyalty among the members. Many of them, however, are of short duration. They change their character and purpose and then disband because of lack of interest or of disagreement among the members. A suitable teacher is essential to the success of the organization.

ADOLESCENCE

9. Meaning of the Term. The term adolescence is applied to that period of life included between twelve and eighteen, or twenty. The ages given are for the average youth. The time at which sex-maturity begins is earlier in warm than in cold climates, and usually somewhat earlier in city than in country children.

10. Leading Characteristics. Childhood gradually merges into adolescence. Some of the traits characterizing the years eight to twelve are strengthened, while others slowly disappear; yet notwithstanding the gradual preparation which nature makes for this change, its manifestation is often sudden and abrupt. Adolescence is the dawn of a new life — a new birth, if you will. It is the period in which the boy becomes a man and the girl a woman. Interests broaden, ideals change, a feeling of responsibility asserts itself, and the youth begins to take life seriously. The period is fraught with danger, but it is likewise open to opportunities of glorious achievement.

11. Physical Development. In most children early adolescence is characterized by rapid growth of the bones and muscles. The nervous system, however, does not keep pace with this growth, and the youth of thirteen and fourteen finds it difficult, if not impossible, to acquire complete command over his movements. This condition of awkwardness or ungainliness means that the youth is unable to coördinate his movements.

Because of this condition, early adolescence is often characterized as the awkward age. His awkwardness makes the youth keenly self-conscious, and any allusion to his condition or actions, however kindly it may be made, or however interested the critic may be in the young person's welfare, is usually resented and considered as a hint that his presence is not agreeable.

But the development of the internal organs is even more marked than that of the bones and muscles, and its influence extends to the intellectual and moral nature. There is a consequent nervous excitement and pressure, and the system is surcharged with energy which must find an outlet. Unless this is provided along the right channels, it often finds an escape through avenues which lead to viciousness. During this climacteric period children need careful attention.

12. Sex Hygiene. Both teachers and parents are confronted by the peculiar problems which arise at the age of sex-maturity. While there are ardent advocates of sex instruction in the schools, there are equally strong opponents to such instruction, and the teacher may find herself between the upper and nether millstones of these opposing opinions. That such instruction is necessary, most parents will admit but many of them are unwilling to have it introduced into the schools, even when they are too indifferent or too ignorant to give proper instruction themselves. It is beyond question that instruction in sex hygiene is primarily the duty of the parents, but because of the neglect of this duty, many teachers of intermediate and grammar school grades find it necessary at some time to give to someone that sympathetic advice which the parent should have furnished. The tactful woman teacher can here be of lifelong assistance to the girls of her school, while the man may do as much for the boys. Both may be obliged to call upon the parents or enlist the interest of some adult of the opposite sex who can safely be trusted to talk to children.

Very often, especially in village and rural communities, meetings of mothers may be called and addressed by some physician or by a competent, sympathetic, tactful person who will be able to give information in such a way as not to hurt the feelings or arouse the opposition of anyone. In fact, in localities where ignorance is the rule, such a course is almost necessary if the teacher concerns herself in the interests of her pupils beyond their instruction in the studies of the schoolroom.

Every teacher should become conversant with this important subject so that she may give proper instructon to the pupils when this duty falls upon her; also that she may be able to do what may possibly be more important — present the subject so clearly and forcefully before parents' associations as to arouse the fathers and mothers to an appreciation of their responsibility in the education of the children along these lines.

Moreover, the general lack of knowledge on this subject leads to false ideas upon which erroneous conclusions concerning the effect of school work upon adolescents are frequently based. Concerning this Dr. J. W. Courtney, the eminent nerve specialist of the Boston City Hospital says:

> Puberty and its attendant dangers to mental and nervous health have caused the expression of many extreme views. There is no question that in both sexes (but especially in boys) the psychical effect of puberty often outweighs the physical; hence we begin to observe the

real awakening of the ego, of the condition of self-consciousness, the proper trend of which means so much for the health of the nervous system. It is a period certainly when nervous and mental aberrations are not uncommon, but are we right in attributing them all, as certain authorities are inclined to do, to brain over-work? Such a contention seems wholly unjustified except in rare instances. The root of the evil lies largely in the mawkish sentimentality and artificial modesty which possess a large percentage of parents throughout the land, and prevent them from explaining to their children the mental as well as physical significance of the changes which the latter are destined to undergo at this period. The result is, in the case of the girl, that the establishment of the menses often comes as a mental shock which may prove the last straw in the genesis of a nervous breakdown, for which her "studies" have already paved the way. In the boy the reaction is different and frequently far more disastrous, for he, finding himself in the possession of a newly-awakened instinct, is often led into habits which may mean little less than absolute mental and nervous ruin.

This subject is well worthy of the serious attention of every parent and teacher. The teaching of practical morality is the key to the problem. The responsibility of the entire matter rests primarily with parents and teachers; but to judge from the prosperity of the very lowest and most offensive sort of charlatans, and from the large number of persons who, under the scourge of the most pitiable mental anguish, seek the advice of reputable physicians, it would seem that this responsibility, great and significant as it is, rests, in many instances, with appalling lightness.

13. Mental Conditions. From twelve to fourteen in girls and from a year to a year and a half later in boys, the perceptive powers develop rapidly. Memory is especially active and imagination reaches its normal stage, increasing in strength with leaps and bounds during the fifteenth and sixteenth years. Conception and judgment are rapidly gaining strength, and reason is beginning to assume its sway. The selfish feelings reach their height and usually begin to decline in the sixteenth year, being supplanted by unselfish feelings which develop rapidly between twelve and fifteen.

In the stress and strain incident upon the development of the reproductive organs, are born passions which the youth alone is scarcely able to control. The love of excitement is strong, and the greatest energy is manifest in following those lines of activity which appeal most strongly to the individual. The "reading craze," the "collecting craze" and the "club craze" are peculiarly prominent during these years.

Parents and teachers who exert the greatest influence over boys and girls of this age thoroughly understand and take into consideration these conditions. Particularly must the growth of judgment and reason be recognized, and appeals be made to them if those in authority would influence conduct. "Any attempt to treat a child at adolescence as an inferior is instantly fatal to good discipline." It is difficult for parents to think of their children as growing men and women instead of regarding them as mere children, and the boys and girls are treated as children when an appeal to their manhood and womanhood would be far more effective.

14. Social Ideals. (a) REGARD FOR THE OPPOSITE SEX. The first change in social ideals is seen in the attitude of the sexes toward each other. Up to the eleventh or twelfth years, a comradeship exists between boys and girls. They share many sports in common and in most respects have similar tastes. With the dawn of adolescence, however, a peculiar aversion to each other is shown. The boys seek companionship of boys, and girls that of girls. Girls look upon boys as rough and "horrid"; boys consider girls to be weak, childish and as devoid of any sense of real fun or of ambition for the great purposes of life. Paradoxical as it may seem, this is the beginning of a sentiment which soon takes an opposite turn, and by fourteen or fifteen the teacher and parents may be puzzled with the boy's or girl's first love affair.

In the grammar grades and the first year of high school, some pupils will be found who crave social excitement, and this craving often leads to dissipation in the form of parties and dances to such an extent as to injure health and sadly interfere with the school work of the participants. Proper school oraganizations managed by the pupils under the supervision of the teacher are beneficial as one means of satisfying these growing social demands and at the same time directing the efforts of the young people along right lines.

(b) ORGANIZATIONS. The gang and club craze which begins about the tenth year, reaches its climax at about twelve in girls, and thirteen in boys, at which ages statistics show the largest number of organizations. Previous to this age the predatory tendency of these organizations among boys usually does not extend beyond playing pranks and such mischief as is considered only as fun by the perpetrators, however the victims may look upon it. But if this predatory tendency is not checked by being directed into useful efforts, it may well develop into malicious mischief and crime. Therefore boys and girls especially should come under the direction of adults. Superintendents, principals and men teachers generally should be in such close touch with the boys that they can be of great assistance in giving advice and suggesting work which organizations of this sort can take up with profit.

Among the most valuable of these organizations are the Boy Scouts for both town and country boys, and corn clubs and pig clubs for the boys on the farm. The Camp Fire Girls and girls' canning clubs, besides numerous organizations in churches and schools are equally valuable to girls. The Aggasiz Association and Bands of Mercy are open to both boys and girls. Those in charge of young people should become familiar with these and other juvenile organizations and assist their young friends in choosing those best suited to their tastes, conditions and means.

(c) PROPERTY RIGHTS. The idea of ownership is manifest early in life, and children generally are more careful to protect what is their own than what is another's. It is not until their social horizon is broadened and the feeling of responsibility is developed that they gain a clear idea of the rights of property. It is important that the obligation not to destroy or injure the property which belongs to another, be strongly impressed upon the minds of boys and girls during this period. Too strong emphasis cannot be placed upon the necessity of protecting public property. Failure to do this will result in vandalism by some, and thieving by others.

(d) MORAL JUDGMENT. Students of child life have collected many expressions of opinion from children from six to sixteen on what should be done with those who disobey rules and commit offenses against persons or property. With scarcely an exception the judgment of the younger children is more severe than that of those over twelve years of age. The child is able to see only the relation between the deed and the rule, or between the act and its results. His conclusion that punishment should follow is natural enough, yet the foundation of such judgment is usually the idea of "getting even" with the offender and not the prevention of a repetition of the offense.

As the capacity for judgment and reasoning develop, the child is able to take a broader view of the situation and will see in it a larger number of relations. He is now usually able to consider the motive and base his judgment of the penalty upon that rather than upon the direct result of the act. The idea of justice to the individual is also more prominent than in younger children. This broader view enables the youth to arrive at a more equitable judgment than is possible with the child.

15. Aspirations and Temptations. Youth is the time of ideals, aspirations and ambition. During this period most of the habits of life are fixed, vocations chosen and ideals whose following determines character, are selected. Consequently in the early part of the period day-dreaming and castle-building occupy much of the youth's thought. He projects himself into the future and decides what he wishes to do and to become; but his decisions seldom last very long, and one ambition quickly replaces another. These aspirations are so intensely personal that they seem sacred, and the child does not reveal them to his elders, or even his parents, unless he feels that he has the parents' confidence and sympathy to the fullest extent. He may, however, reveal these aspirations as well as other confidences to his intimate friends of the same age.

The feelings are intense, and the desire for companionship is strong, and this is the time when close friendships with companions of the same age and sex are formed. If the chosen associates are worthy, these friendships are beneficial; if unworthy, they may lead to the blasting of a life. The hero-worship which began in the tenth and eleventh years is intensified, but the ideal may be transferred from an older person to a companion nearer the age of the individual, or the ideal adopted may be some character of literature which at the time appeals strongly to the youth.

The desire for companionship combined with the craving for amusement and the opportunity to work off surplus energy, lead young people of this age to many excesses, to breaches of etiquette, and not infrequently to the playing of pranks which are anything but harmless: Boys and girls of this age are easily influenced, and boys especially are subject to many temptations which if not counteracted by the influence of home and friends will lead them to form habits that will cripple their usefulness for the remainder of life. But this susceptibility to influence has its good as well as its evil side. As during these formative years one may become wedded to habits that will destroy one's usefulness, so may one fix those habits that lie at the foundation of the noblest character. Those who have made a study of sattistics of crime and religion, find that the greatest number of first commitments for crime occur between twelve and sixteen, and that likewise the greatest number who experience a special religious awakening are found within the same age limits.

16. Mental and Moral Stress. The youth becomes a critical judge of himself and compares what he is with what he aspires to become, and the result is seldom to his satisfaction. "Only a few at adolescence feel themselves so good or so happy that they are content to be themselves." What the youth aspires to become he wishes to attain to at once, and he is often extremely impatient of the physical limitations placed upon him by his environment. He frequently broods over his condition, and at times is morose and unhappy. Girls often burst into tears without any apparent cause or condition which they are able to explain.

This is likewise the time of the beginning of skepticism and doubt. The capacity to think things out is beginning to assert itself and the youth is disposed to rely upon his judgment implicitly. He is likely to question what he can not understand, and since there are many things which are entirely beyond his understanding, he becomes doubtful as to what is true regarding the explanations that are offered for many of the phenomena of nature, and he is especially likely to be mystified and troubled by the deeper problems that have to do with the intellectual and religious life. Most of these doubts and longings are kept to himself, or shared with bosom friends.

Again, the rapid growth of the tissues reduces the system for the time being below its normal power of resistance, and this condition, combined with the intense mental strain which most young people undergo at this period, subjects them to a stress which parents and teachers altogether too often fail to appreciate.

17. Conduct. The bearing which the physical and mental condition of early adolescence has upon conduct is decidedly marked. Somewhat extensive records of the conduct of boys between eleven and eighteen years of age show that at eleven conduct is good in 70%; at twelve in 63%; at thirteen in 64%, and at fourteen in only 58%. From this age the per cent rapidly rises until at eighteen 74% of the boys are recorded as having good conduct. An eminent authority says: "By nature children are more or less morally blind, and statistics show that between thirteen and sixteen incorrigibility is between two and three times as great as at any other age." Listlessness, disobedience, laziness and truancy are the offenses of which the teacher most frequently complains, and because of lack of understanding between teacher and pupil, as well as because of the failure to provide for the needs of this period in the course of study, many a boy and girl drops out of school between thirteen and fifteen. "Defective nutrition of the mind also causes a restlessness which enhances all the influences which make boys and girls leave school." Young people of this age should be treated as equals by their elders. They are upon the threshold of manhood and womanhood, and this new relation appeals to them with unusual power. To treat them as you treat younger children is to lose their confidence and usually to gain their everlasting dislike.

18. Boys and Girls. Boys and girls show certain contrasts during early adolescence.

(a) GROWTH. Boys are usually taller than girls until the twelfth year, and heavier until the thirteenth, but from thirteen to fifteen girls are taller and heavier. After fifteen boys exceed in both weight and height. Most girls cease to grow at seventeen. From nine to thirteen the rate of growth in boys diminishes, and during the tenth year there is very little growth. From thirteen to eighteen the increase in height is rapid. From seventeen to twenty the increase in weight in boys is greater than that in height. The periods of accelerated growth for girls are usually one year earlier than for boys. The ninth is usually the year of least growth, and the fourteenth that of the greatest. The period of most rapid increase in both weight and height for the boys is from twelve to seventeen. In nearly all cases there is diminished rate of growth of both boys and girls during the two years preceding adolescence.

(b) MENTAL ACTIVITIES. The brain and nerves reach maturity in girls earlier than in boys, and the effect is seen in the difference in school work during this period. In general girls remember better, are quicker and more accurate in the reproduction of all impressions, and they learn more readily lessons which depend upon memory rather than reason and judgment. It is probable after the fifteenth year boys will begin to excel in the use of the reasoning powers, but they are still slower and less accurate than girls. However, in the next year they gain in rapidity and accuracy.

(c) MORAL INFLUENCES. Girls are usually more open to suggestion and advice from adults; boys exhibit more independence. They are, however, under right treatment, as obedient as girls. Much of the roughness of boys is merely the working off of surplus energy and has no purpose to annoy or disobey back of it. Girls are usually the more secretive and they occasionally practice little deceptions which boys scorn as childish or silly. Under trying conditions girls exhibit equal or greater fortitude and courage than boys.

19. Early Training. Fortunate is the youth who enters upon the period of adolescence with right habits in the forming, good ideas of right and wrong and high ideals. If he has been under the right sort of influences during the preceding years, he will usually be well prepared for the on-coming struggle. It is therefore of vital importance that in the primary and intermediate grades particular attention be given to the formation of right habits, the inculcation of right ideas of right and wrong, and the fostering of high ideals. For this training the home is responsible to a far greater extent than the school.

20. Co-education. A study of adolescence shows that from twelve to sixteen, at least, girls and boys differ in tastes, development and degrees of maturity. "The girl at the same age is older than the boy," and most boys appear at a disadvantage when placed in classes with girls of the same age. This is perhaps one reason why so many boys leave school between twelve and sixteen. Authorities also agree that, during early adolescence at least, the ends of discipline are better served where the sexes are kept apart and the boys are taught by men and the girls by women. Notwithstanding the many advantages of our co-educational system, the foremost students of education in the United States are looking with favor upon the separation of the boys and girls for at least a part of the time and for the purpose of providing different lines of work during a part of the period covered by the grammar grades and the high school.

21. Passion for Reading. With the broadening of the child's vision comes the desire to read, and it frequently happens that the more he reads, the more he wants to read. What to do with this passion for reading is often a puzzle to both parents and teachers. First of all, this desire should not be suppressed; neither should it be allowed to gain such a hold upon the child as to interfere with his school work, his home duties and his hours of sleep. Teachers and parents should assist in planning the reading and selecting books. Consult librarians. A little planning in advance will often prevent the perusal of worthless and vicious books, and at the same time place before the children books which thrill them with joy and ambition. Girls have a greater desire for romantic fiction, and boys for stories of adventure, and in their choice of reading boys are guided more by reason and girls by sentiment. Boys seldom confess to a liking for a purely girl's book, but girls freqently admit that they like stories about boys. With these facts in mind, the teacher should be able in a great measure so to influence her pupils in the selection of their reading that they will avoid excesses and gain intellectual and moral strength while satisfying their desire for books. The department of public instruction in every state has carefully selected lists of books for school libraries, and these can be obtained without expense by any teacher who will write for them. They will be found very helpful in selecting suitable books for children and young people.

22. Fatigue. When a person has been at any kind of work or play for some time, much of the vigor and elasticity which characterized his earlier efforts depart, and he experiences a feeling of fatigue or weariness. After a period of rest his interest and strength are renewed and he is able again to do his best. All action seems to proceed in this rhythmical way, a period of rest following a period of activity. As has been said, in the earlier years of adolescence there is marked activity, especially in those plays which call for the use of the larger muscles. At this time, too, it seems wise that exercise should sometimes be carried to the point of fatigue, because such exercise causes the blood vessels to be expanded and surcharged with blood to provide for the rapid growth that is coming. But it is a fact that with this increased activity fatigue comes sooner and more easily. In school, then, teachers must recognize fatigue and arrange their programs of work so as to allow for rest and recuperation.

Fatigue in school children manifests itself by slower work, by an increase in the number of errors and inaccuracies they make, by carelessness in their work and inability to fix their attention upon their tasks. Work that is continued beyond a certain fatigue point is liable to breed slovenliness. The children grow capricious and show all those symptoms of nervousness of which teachers and parents so often speak. As a matter of fact, it sometimes happens that children are fatigued when they come to school, and that the proper place for them is in the open air and not in the schoolroom. This often occurs as the child is passing puberty. It is not always easy to convince parents of this, and the teacher, when satisfied of the condition, must make as much allowance as possible for it. Often when teachers fail to recognize in fatigue the cause for the restlessness, disobedience and flightiness of pupils, they punish unfairly. Punishment makes the child more weary, listless and indifferent than ever; only rest and diversion can cure fatigue.

23. Gymnastics. Formal gymnastics are valuable in the schoolroom, if the pupils can be interested in them and encouraged to enter into them with spirit and determination. This is not a difficult matter with boys and girls of grammar-school age, especially if the movements can be accompanied by music, for at this age rhythmical movements are especially attractive, and children naturally take to those games which involve repetition of the same motions at regular intervals. They enjoy marching, dancing and all rhythmical games and profit by them. This fact furnishes the key to the gymnastic exercises.

24. Play. Every normal child takes hearty delight in play. Play gives strength, courage and confidence and makes the child energetic, quick to decide and ready to act. For these reasons and because active play gives the best possible exercise, successful teachers encourage their pupils to play, take an active interest in their games and enter into them *whenever it is possible* to do so. However, as the child grows toward maturity *the plays* in which he is interested *change their nature* decidedly.

25. Sports and Games. At about nine or ten years of age the boy begins to take more active interest in games of an athletic nature and to think more of playing in company with other boys. He delights in teams which act in obedience to a captain and which struggle together for victory. Whether alone or in company with others, competition is a powerful motive, and the greatest pleasure that a boy can feel is in overcoming someone else. He loves courage and endurance and will manfully strive to control himself and subordinate himself to others if in so doing he and his team can win.

Sometimes the same spirit is manifested by the girls, but to a much less degree. They do not care for the same violent forms of competition nor are they so much inclined to work together, but there is usually an increasing interest in games of chance, of cards and such table-games as they are familiar with. Possibly some of this is due to the fact that they are usually discouraged from entering into the lively outdoor games. The wise teacher will do all she can to interest the girls and will keep them running, jumping or taking part in the milder games of the boys, so long as they can enter into them with interest and zest.

The outdoor sports which particularly attract the boy in his early 'teens are hunting and fishing, riding, rowing, sailing and swimming, the last becomes almost a passion during the spring and summer months. Boys and girls of this age take great interest in nature and the teacher will take advantage of this to encourage a study of plants and an appreciation of birds and their life. Probably she will be successful in overcoming the natural desire to kill birds and other small animals and substitute in place of it a kindling admiration for their beauty and an interest in their habits. Boys like wrestling, running, jumping, scuffling, boxing and even fighting, and a teacher will usually find that the boys who indulge most freely in these activities are those who give the least trouble in school and who need the least restraint and moral discipline. It is the milk-and-water boy that needs care at this time of life.

The most popular game and the one which gives the best opportunities for individual excellence is our national game of baseball, and every teacher ought to know at least the general rules of that manly game. Many a woman has found her way into the confidence of her boy pupils by being able to show an intelligent interest in their games and to be somewhat acquainted with what is going on in the world of sport outside the schoolroom. Indoor baseball, which is a good game for girls, basket ball and hand ball all serve the double purpose of physical development and team work, which is the delight of young people of this age.

To sum it all up, then, the teacher of the sixth, seventh and eighth grades need not be disturbed by the rough-and-tumble character of the boys, but instead of trying to quell this spirit and reduce these young barbarians to gentility, will content herself with trying to direct the energy into right channels or at least in keeping it within the bounds of reason. Abundant opportunity should be provided for the sort of play that boys of this age enjoy, but at the same time the boys and girls should have opportunity to learn what refinement is. Manuals giving full directions for baseball, indoor baseball, basket ball and other games, can be procured for a few cents each, and wherever there is sufficient interest in any of these games it is a good plan to organize a club, get one or more copies of the manual and learn the game.

26. A Caution. While the teacher is wise to encourage athletic contests among her pupils and to urge them to play hard and fast, she should be careful here, as elsewhere, to watch after the interests of the individuals that compose her school. Under the influence of exciting competition or spurred on by the approval of the teacher and mates, the children often play beyond the safety-point of fatigue and receive more harm than good. This is particularly true of the delicate, nervously-constituted ones who perhaps are little accustomed to such violent work, who have been petted and pampered at home, and now, feeling the stir of new life, go far beyond their powers. Occasionally a boy will be found so different from his mates, so poorly adapted by nature to play with them, that it is unkindness to drive him forth. Happily these exceptions are few and usually they may be made still fewer if the teacher will look intelligently into the causes of things.

27. Conclusion. "Let us not be weary in well doing, for in due season we shall reap if we faint not." This exhortation of Saint Paul should be the motto of every teacher. Notwithstanding the difficulties in the way, persistent systematic effort will overcome them, and as surely as day follows day and one year succeeds another, just so surely will the time of awakening come to every boy and girl. It may come gradually, like the dawn; it may appear suddenly like a burst of sunshine through a rift in the clouds, but come it will. It is a time of regeneration, when all things become new. The view of life broadens; experiences deepen; some great ideal is selected, the following of which becomes a life purpose. The youth takes a long look into the future and sets forth upon life's journey with an energy and zeal hitherto unknown to him.

28. Military Training. While this section applies more particularly to boys in the high school, some of the work described can be done by boys in grammar grades, provided it is under the direction of an experienced leader. Let it be said at the beginning that this training does not mean militarism, neither does it have for its objective, enlistment in the regular army. Military training has been compulsory in the high schools of Boston for more than half a century, and the proportion of enlistment in the regular army from Boston and its suburbs is the lowest in the country. For more than a third of a century military training has been required in the high schools of Washington, D. C. with a similar result.

(a) THE FUNDAMENTAL IDEA. The basic idea of military training in schools is physical training accompanied by military instruction. In other words it is a training for citizenship which gives the boys strong healthy bodies and such knowledge of military affairs as will enable them in the future to be efficient defenders of the country should occasion for defense arise.

(b) THE WYOMING PLAN. In 1911 Lieutenant Edgar Z. Steever of the regular army was sent to Wyoming as inspector-instructor of the National Guard of that state. Early in the year he obtained permission of the board of education of Cheyenne to introduce military training into the high school of that city. The service was made entirely voluntary and he began with sixteen boys, ranging in ages from twelve to eighteen years. In five years his plan had been adopted by every high school in the state and a number of high schools in neighboring states. Because of the remarkable results obtained, Lieutenant Steever's work has attracted wide attention, and it is well worth consideration by all who are interested in the proper training of youth.

The chief features of the plan are:

(1) Dividing the boys into squads of eight, each squad to include some of the strongest, some of the medium and some of the weakest boys.

(2) Election of the leader of each squad by the members by secret ballot.

(3) Training for competitive contests by squads in which the winning squad receives a medal.

(4) Scholarship contests by squads conducted on the same general plan as the drill contests.

(c) ADVANTAGES. The chief advantages of this system over the ordinary school athletics may be given as follows:

(1) It gives every boy an equal chance for physical training. By the old system the strongest boys — those who make the best athletes — are picked for the various teams and given special training, while the large number who may need the training more than the chosen few, receive little or no attention. By placing strong, medium and weak boys in each squad, all are given equal advantages.

(2) The best sort of training in citizenship is afforded by the election of leaders. An inefficient leader means an inefficient squad, and the boys soon learn that if their squad is to win, the leader must be chosen solely on the ground of his fitness for the position.

(3) The squad affords the greatest incentive to clean living and clean thinking. The boys soon learn that contests cannot be won if they indulge in bad habits.

(4) The squad is one of the best means of teaching true democracy. Members are chosen without regard to family, social standing or wealth. All are on the same footing and banded together by the supreme idea of loyalty to the squad.

(5) Wherever the system has been introduced, truancy has disappeared, the discipline of the school has been greatly improved and the percentage of boys leaving school before

the completion of the course of study has been greatly. reduced.

We have set forth briefly the work taken up and the purposes sought in this system of training. In addition we wish to add a plea for its careful consideration by teachers, school officers and parents. Possibly the term *Military Training* is unfortunate, because it suggests militarism to a large number who disapprove of militarism in the schools. But the sort of military training here described is as far from militarism as anything can be. It is far better than the athletics — football, baseball and the like — which are encouraged in all secondary schools. Teams of the best athletes are organized and these boys who need it least are given special training, while a large majority of the boys, among whom are those who need physical training most, are neglected. The system here described gives one boy as good training as another; it makes for clean living and clean thinking; it developes the physical system in the best possible manner, and it trains for citizenship.

29. Books for Teachers. *Training the Boy.* W. A. McKeever. MacMillan Co., New York; Chicago.

Training the Girl. W. A. McKeever. MacMillan Co., New York; Chicago.

Plays and Games for Schools. C. P. Cary. Democrat Printing Co., Madison, Wis.

Book of Outdoor and Indoor Games. Mrs. B. Kingland. Doubleday, Page & Co., New York.

Spalding's Official Guides. *Baseball, Basket Ball, Football, Lawn Tennis,* etc. American Sports Publishing Co., New York.

The Boy Scout Scheme. Boy Scouts of America, New York.

Boy Training. John L. Alexander. Association Press, New York.

The Way to Win the Heart of the Pupil. Weimer. MacMillan Co., New York; Chicago.

Girl and Woman. Latimer. D. Appleton Co., New York.

Literature of the Playground Association of America, New York. Sent free on application. *Games Every Child Should Know*; *Folk and National Dances*; *The Home Playground.*

Camp-fire Girls. Official Volume. Geo. H. Doran Co., New York.

What a Mother Should Tell Her Daughters. Isabelle Thompson Smart. Funk & Wagnalls Co., New York.

CHAPTER ELEVEN

PSYCHOLOGY

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1. Psychology and Teaching. All successful teaching is founded upon the laws of mental development, and the teacher needs a knowledge of these laws so far as they have been worked out. Since the laws of mind deal with the immaterial, they are more difficult to discover than the laws which govern the material universe. Nevertheless a sufficient number of these laws have been determined to guide teachers and others who are engaged in training the young. Psychology is the science which treats of the mental powers, their development, growth, and laws which govern them.

Contrary to the prevailing opinion, psychology is not a difficult subject. To one who loves children and his fellow men it is one of the most fascinating subjects, and every teacher who approaches it from the view-point of observation and discovery soon becomes intensely interested in its pursuit. Modern elementary texts on psychology are written in a clear, simple style, free from technical terms; any teacher can gain through home study a good working knowledge of the subject.

It is not our purpose to present here a treatise on psychology, but to discuss the underlying principles upon which all successful teaching depends. These principles as set forth are not mere theories, they have been discovered by observations extending through centuries, and formulated by the greatest educators of the ages. We call attention to these facts at the outset, because inexperienced teachers are liable to look upon psychology as highly theoretical and abstract, and for this reason to consider a knowledge of it unnecessary. Such an opinion is erroneous and no progressive teacher will entertain it.

MIND AND BODY

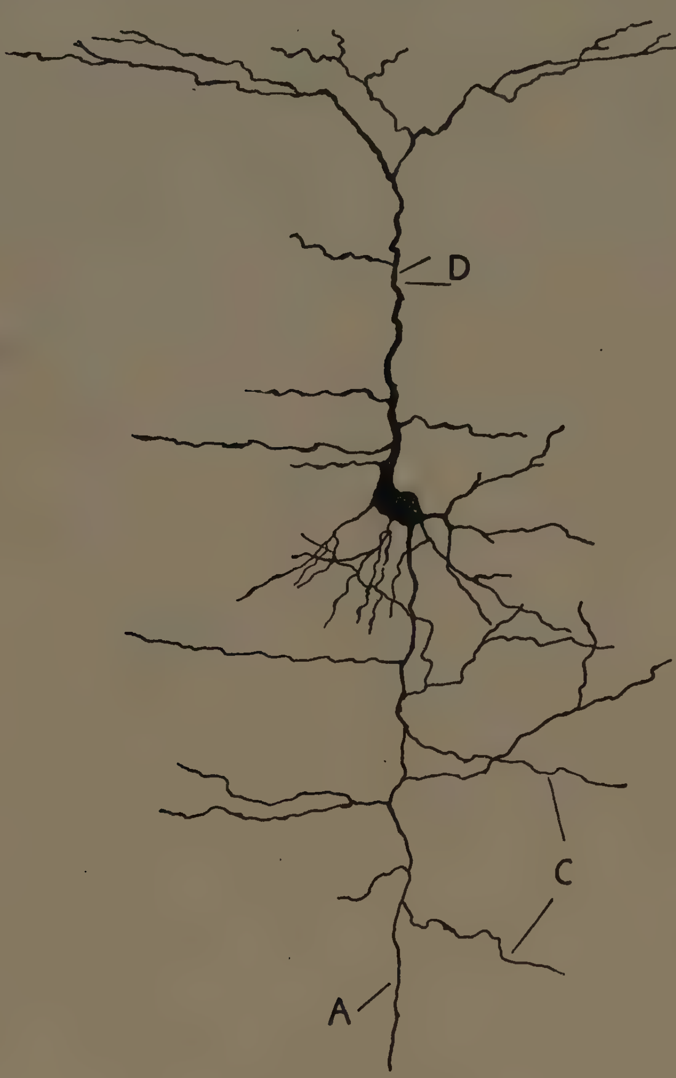
2. The Nervous System and Mental Activity. We are made aware of the world about us through the agency of the senses — sight, hearing, taste, touch, smell, temperature, and those agencies through which we experience pain, the stress of muscular effort, and the conditions of the internal organs. Formerly psychology recognized only five senses — sight, hearing, touch, taste and smell — but modern psychology recognizes many more. Moreover, the mind is aroused to action through the impressions brought to it by these agencies. We are able to store up, as it were, these impressions and to recall many of them; we recombine our experiences and form new ideas; we compare one idea with another and decide that they are alike or unlike; we are strongly affected by some experiences and slightly affected by others; we make decisions and perform such acts as are necessary to secure the fruits of choice, or we refrain from action. We at once recognize these activities as those of the mind. Until very recently it has been the custom of psychologists to speak of each sort of activity as a distinct mental power, and the terms *sensation*, *perception*, *memory*, *imagination*, *feeling* and *will* are still found in most works on psychology and pedagogy. The latest thought, however, considers the mind a unit, and prefers to consider what we commonly call memory, imagination, etc., as phases of activity; so when we speak of memory, we speak of the mind acting to recall and bring into consciousness some past experience, not of any particular part of the mind as acting in this way. Therefore, while we use these terms in our discussion because of their familiarity, we wish the reader to bear in mind that we refer to the activities of the mind, instead of any particular faculty or power.

There are many evidences of the interdependence of mind and body. Sensations of hunger and thirst arise from the demand of the physical system for nourishment; a slight injury causes pain, and a severe injury or illness strongly affects the mental activities — the dyspeptic is invariably a pessimist, and the man with a good digestion is usually an optimist. We know also that certain drugs, such as ether, chloroform, alcohol and opium, by affecting certain organs of the body, interfere with our mental processes.

This connection between mind and body points to some organism whose work it is to connect and correlate the different functions of the body, and to enable the parts to act together. This organism is the nervous system which consists of two great divisions, the central nervous system comprising the brain, the spinal cord and the nerves that branch from them, and the sympathetic system, which comprises the ganglions and nerves that control the vital functions,— respiration, circulation and digestion. Our discussion is limited to the central nervous system.

3. Nerve Cells or Neurones. Nerve tissue is composed of cells of peculiar structure to which the name *neurones* is generally applied. Each neurone consists of a nucleus or nerve center and two thread-like extensions which may vary in length from a fraction of an inch to several feet, for some of them extend only to nearby centers and others from the brain to the remotest parts of the body. The accompanying illustrations show first one of these neurones as it appears when highly magnified, and secondly a vertical section through the cortex, also highly magnified. Their number is beyond estimate, and while no neurone grows into another, no neurone is completely isolated. Every one stands in a special relation to others with which it is in close proximity or comes in contact. The nervous system equals the sum of its neurones.

(a) Functions. The chief function of the neurone is to receive and transmit impressions. In other words, the nerve cell is sensitive to the action of other objects upon it, and when excited or stimulated at one end it transmits the stimulus to the other end. For instance, a neurone extending from the brain center controlling the movements of the right hand to the end of the forefinger in that hand is stimulated by contact of the finger with some object, as a piece of sandpaper, and it transmits this stimulus to the brain center where it is again transmitted to the neurones controlling the muscles that move the hand, and through them these muscles are caused to act and the hand is moved over the paper.



A NEURONE

Again, the ability to modify their actions so as to adapt them to conditions is an important characteristic of neurones. The tendency of all neurones is to act again in the way they have acted before, and this tendency lies at the foundation of habit. The establishing of right actions in the formative period of life is therefore all important.

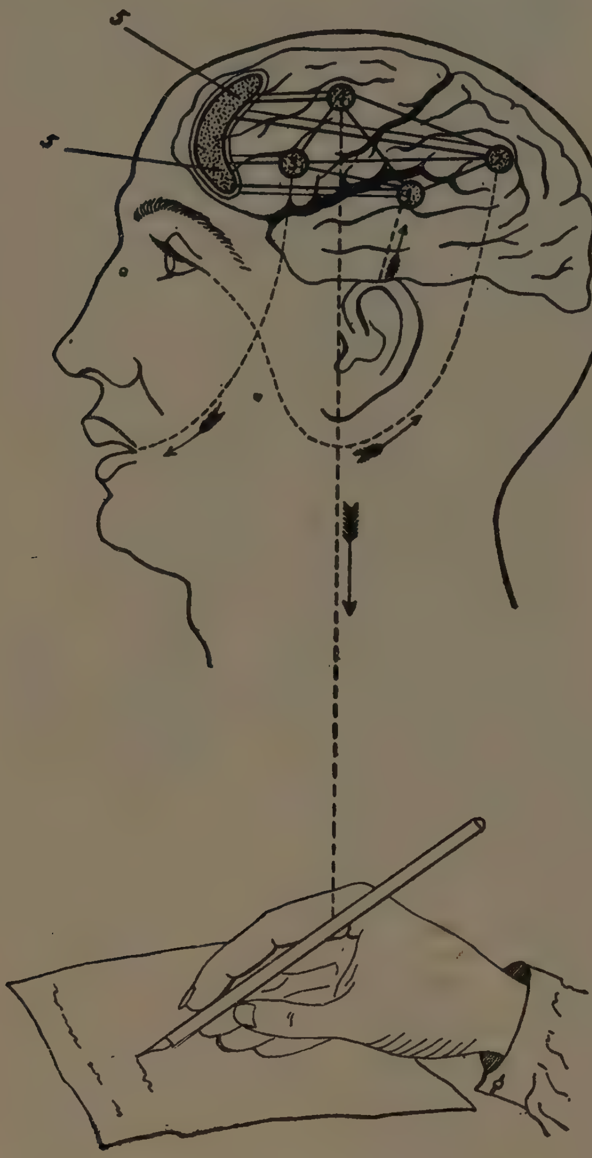


DIAGRAM SHOWING THE RELATION BETWEEN SENSORY AND MOTOR CENTERS

1. Auditory Center.
2. Visual Center.
4. Motor Center.

The impression is conveyed to either the auditory or the visual center, and from the motor center the impulse to write is sent forth.

(b) CLASSIFICATION. The classification of neurones is similar to that of the fibers in the white matter already described. "There are cells directly sensitive to environment, cells directly active in causing muscular contraction and cells acting as intermediaries between the former and the latter."[*] The neurones therefore are divided into three classes, *sensory*, *motor* and *associative* or *connecting*.

The sensory neurones are found in every part of the body, from which they transmit the sensations received to the spinal cord and brain.

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[*] Thorndike's *Elements of Psychology*.

The motor neurones are distributed to all the muscles.

The associative neurones form the most elaborate mechanism of all. They connect the motor with the sensory nerve cells, and enable the body to respond to the sensory impressions in a movement that results in doing what is necessary.

"The greater part of the bulk of the human brain is given up to such connecting cells, and the more important part of the work of the nervous system is the work, not of receiving stimuli from the sensitive parts of the body, nor of discharging stimuli to the muscles, but of turning stimulus into discharge, connecting outgo properly with income, suiting expression to impression, action to circumstances."[1]

(c) GROWTH AND DEVELOPMENT. The brain reaches its full size by the fifteenth or sixteenth year. Even by the eighth year this organ has nearly completed its growth so far as size and weight are concerned. But we know that the adult can do many things that are impossible to the youth. One of the reasons for this is that the associative cells develop slowly, and the brain does not reach maturity until sometime after it has attained its full weight. The understanding of this fact is of the greatest importance to the teacher of pupils in the intermediate and grammar grades, for without this knowledge she is liable to impose upon these pupils tasks which it is impossible for them to perform in a satisfactory manner. In the study of the nervous system from the view-point of psychology a careful distinction should be made between growth and development.

4. The Brain. The brain is the great center of the central nervous system and the most wonderful organ in the body. It fills the entire cavity inclosed by the skull and known as the *cranium*. It is divided into four parts — the cerebrum, or upper brain; the cerebellum, or small brain; the pons, and the medulla oblongata. While a brief description of the smaller divisions is essential to the understanding of our subject, our chief interest is in the cerebrum.

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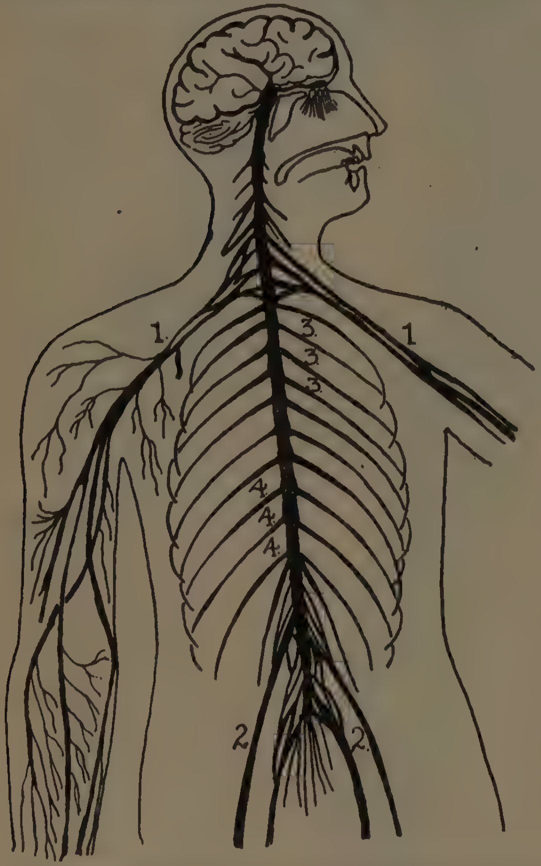
[1] Thorndike's *Elements of Psychology.*

BRAIN AND NERVES

This diagram shows the brain, spinal cord and the chief nerve trunks branching from it.

(a) The Cerebrum. The cerebrum fills all the upper part of the cranial cavity and comprises over seven-eighths of the brain. It is divided into two equal parts called the *cerebral hemispheres* by a deep fissure extending from front to back. In shape the hemispheres closely resemble a coffee bean. On their under side they are united by a strong white membrane called the *corpus collosum*, which forms the roof of two small cavities lying side by side and known as the *lateral ventricles*.

(1) *Convolutions*. The brain substance in the hemispheres is arranged in folds called *convolutions*, which are so grouped as to divide each hemisphere from front to back into four lobes, the *frontal*, the *parietal*, the *temporal* and the *occipital*, each lobe being named from the bone under which it lies. This arrangement of the brain gives it a large amount of surface for the gray matter, whose area is estimated to be equal to that of the entire trunk.



THE BRAIN AND LARGE NERVE TRUNKS

1. Nerves to the shoulder and arm.
2. Nerves to the leg.
3. Nerves to the chest.
4. Nerves to the lower parts of the body.

(2) *Gray and White Matter*. The brain is composed of two sorts of tissue, known respectively as the gray and the white matter. The gray matter forms the *cortex*, and is distributed over the surface of the convolutions. It has an average thickness of about one-eighth inch, but varies in thickness in different lobes, being thinnest in the occipital and thickest in the frontal part of the parietal lobe. Thin as the cortex is, it is

arranged in four layers, each composed of cells of different kinds. Fibers extending from these cells interlace in all directions. The cortex is the seat of our power of thought, sensation and volition. Later we give more attention to its structure.

The white matter constitutes the larger part of the brain, and consists of innumerable fibers which may be classified under three heads.

(1) Those which unite the corresponding lobes of the hemispheres.

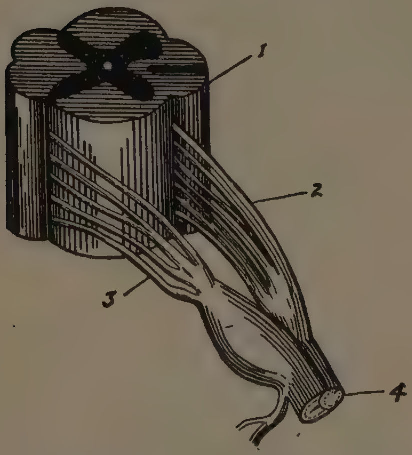
(2) The associative fibers, or those which unite neighboring as well as distant parts of the same hemisphere. These fibers connect excitable areas with each other, and with areas which produce action.

(3) The fibers that connect various portions of the cerebrum with the cerebellum and spinal cord. The fibers are of two kinds, those which convey impressions from the surface of the body to various centers in the cortex, and those which convey impulses from these centers in the cortex to the different parts of the body and cause action. The first are known as *afferent* (in-bearing) fibers, and the second as *efferent* (out-bearing) fibers. They are also designated as sensory and motor fibers.

(b) THE CEREBELLUM. The cerebellum is situated at the back of the head, below the cerebrum. It is divided into hemispheres and each hemisphere is connected with the cerebrum by sets of nerve fibers. The gray and white matter are intermingled more fully than in the cerebrum, and the white matter unites into a system of nerves that extend through the spinal cord to all parts of the body. The chief function of the cerebellum is to harmonize the muscular movements that enable one to maintain an upright position. One whose cerebellum has become injured, staggers like a drunken man when attempting to walk.

(c) THE MEDULLA OBLONGATA. The medulla oblongata is really the enlarged upper end of the spinal cord. In it the nerve fibers from the brain to the spinal cord cross to the other side, so that the right hemisphere controls the left side of the body, and the left hemisphere the right side. The left hemisphere is usually the stronger, consequently most people are right-handed. The medulla transmits nerve impulses to the brain, serves as an important center of reflex action and presides over those involuntary movements necessary to life — breathing, circulation and digestion. Because of this it is sometimes called the "vital knot.

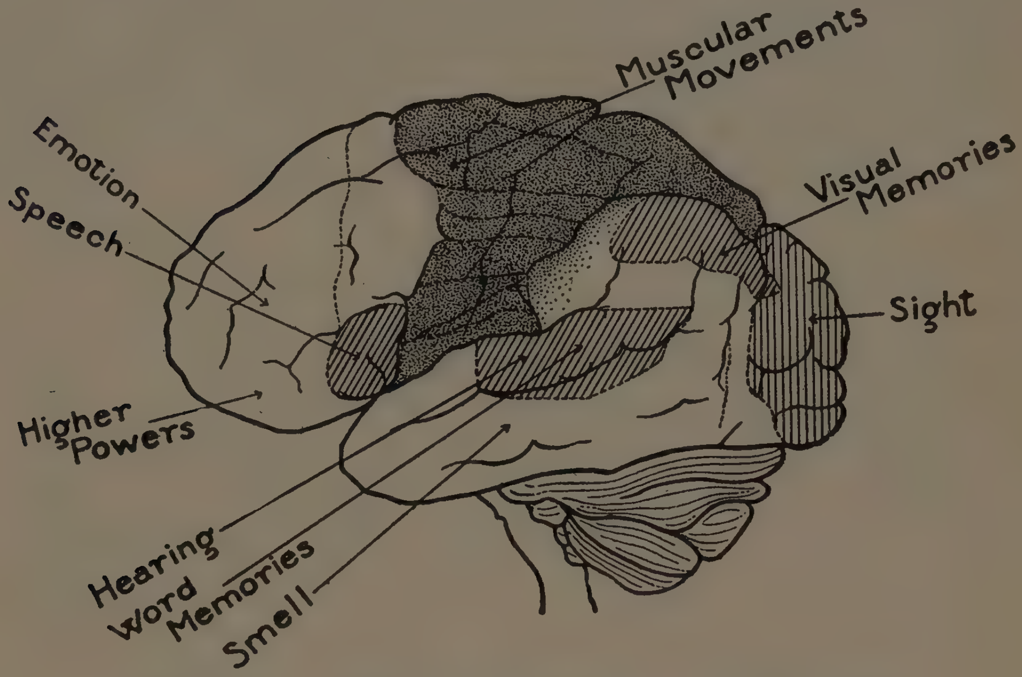
5. The Spinal Cord. The spinal cord fills the canal in the spinal column. Like the brain it is divided by a fissure into right and left halves, and each half is divided into three columns. The gray matter is in the interior as shown by the diagram. The white matter consists of nerve fibers which convey impressions to the brain and impulses from that organ to the various parts of the body. The afferent or sensory nerve fibers branch off from the posterior, and the efferent or motor fibers from the anterior column.



SECTIONS OF SPINAL CORD
1. The Cord. 3. Motor Nerve.
2. Sensory Nerve. 4. Nerve Trunk.

6. Localization of Brain Action. Each neurone, it would seem, has its special function, and neurones having the same function are arranged in groups; hence we find that certain areas in the cortex constitute the respective areas of certain functions, such as areas where sensations of sight, hearing, taste and smell are received or registered. Also areas that control the voluntary movements of the arms, legs and other parts of the body have been located. These centers, so far as they have been discovered, are shown in the accompanying diagram, but there is a large part of the brain which is not yet mapped. Moreover, we must not consider a "center" to include only an area in the cortex, for it includes "the entire course of the conducting group of neurones, or some important part of that course."

When any area of the cortex that presides over a given function is injured, the function ceases, or it is performed imperfectly. To illustrate, injury to the motor area controlling the movements of the right arm, will wholly or partially paralyze that arm; injury to the area controlling the movements of the vocal organs deprives one of the power of speech, and injury to the center of vision renders one blind. Injuries arising from accident, such as the formation of a clot of blood over a portion of the brain or the pressure of a small piece of bone of the skull as the result of a blow on the head, may be remedied by a surgical operation, but those caused by disease are usually beyond remedy.



THE BRAIN SHOWING LOCALIZATION OF FUNCTIONS

Caution. The localization of functions here described is entirely different from the so-called science of phrenology, which locates the different powers of the mind in "bumps" or definite parts of the brain. The folly of such a theory is at once apparent when we consider that the memory of visual impressions is in the optical centers, the memory of sounds in the auditory centers and the memory of each act in the centers that control it. Moreover, thought, imagination, the emotions and will have never been localized. "The student should, therefore, not harbor any fanciful guesses, such as that each neurone corresponds to some one idea, or that one kind of a neurone goes with thought, another with emotions, or that neurones hold thoughts and feelings in them or tied to them. The neurone is connected, and it is the duty of the teacher and the parent to see that right acquired connections become thoroughly established during the period of childhood and youth while the nervous system is in a plastic condition.

ACTIVITIES OF THE MIND

7. Consciousness. Consciousness is the natural state of the mind when we are awake. We realize the fact that we know our surroundings and that we also know many experiences of the past, which we can recall by memory. We also realize that we can make use of these experiences in projecting our future. Hence we might say without exaggeration that consciousness is the state of being awake. We are unconscious only when asleep or when suffering from disease or injury that affects the brain. The contrast between *wide-awakeness* and *sound-asleepness* is all that *direct* experience tells us of what consciousness really *is*.

8. Attention. Attention always accompanies consciousness. We speak of it as the directing of consciousness upon some particular object or thought. Let us suppose a child in a garden and surrounded by flowers. Butterflies are flitting through the air and birds are singing in the trees. He is conscious in a vague sort of way of his surroundings, then he sees a butterfly and in its pursuit loses sight of the flowers. Again, he is attracted by the song of a bird, and tries to locate the little songster. In this way he passes from one object to another until he becomes weary. When in a state of consciousness the mind is always attentive to something. Inattention or lack of attention means simply that the one against whom the charge is brought is not fixing his attention upon the matter under discussion or upon the object which he is expected to observe.

(a) VARIETIES OF ATTENTION. The best of modern authorities recognize three sorts of attention — passive attention, active attention, and secondary passive attention.

(1) *Passive Attention.* We direct our attention spontaneously or involuntarily to strong impressions, such as a loud sound, a bright light, an unusual odor, etc. The tendency to follow movement is also spontaneous. This tendency to direct the attention is inborn and forms a prominent feature of the mental activity of the young child. The stimulus is external, that is, it originates in the object, not in the mind. We do not look at the light nor listen to the sound because we first decide to do so, but because the strong impression they make impels us to attend to them. While passive attention is characteristic of childhood, the adult is never wholly free from it. The best trained intellects may so concentrate their powers upon some subject that for a time everything else is excluded from consciousness; but such an interval of concentration is of comparatively short duration, then spontaneously the mind turns to something else. Try to solve a difficult problem in mathematics and see how long you can hold your undivided attention upon it.

(2) *Active Attention.* Active attention is that which is directed by one's own volition. It enables one to set aside what has been spontaneously brought into consciousness for some other object which one wishes to give consideration. The pupil uses active attention when he applies himself to studying his lessons. The teacher uses active attention in preparing her work and conducting her school. The business man uses active attention in the administration of his affairs. Without active attention we should be at the mercy of our environment. It is fortunate, therefore, that as we pass from childhood to youth and from youth to the adult period of life, passive attention gradually gives

place to that of the active sort until life is dominated by some great purpose, upon which active attention brings our powers to bear. Since active attention is directed by the will it is frequently styled voluntary attention. Active attention lies at the foundation of our power to acquire knowledge, and the teacher who would succeed must be able to train her pupils in developing this power. Many devices and methods for securing and retaining attention are offered teachers, but unless they conform to the natural laws here given, they are of little value.

(3) *Secondary Passive Attention.* Every time we are placed amid new surroundings, begin a new study or engage in a new line of work, our minds are distracted by the many strong impressions arising because of the newness of the situation, and it requires a good deal of effort to give attention to our work. Fortunately, however, these distracting impressions become commonplace in a short time, and our active attention has become *secondary*, or acquired *passive attention*. If we had to expend each day the same amount of effort to keep our minds upon our work, we should make but little progress, for in order to become efficient one must give one's undivided attention to the task at hand. This sort of attention is an acquired art, but an art that can be acquired only by effort, extending through a period of months and years of active attention. One of the most valuable and lasting services that a teacher can render her pupils is that which will enable them to acquire this art.

(b) TRAINING IN ATTENTION. The teacher can do much to help her pupils to acquire the power of attention, and in this work she will find the following suggestions helpful:

(1) Let your pupils feel their successes. Whenever a pupil accomplishes something through continuous effort, such as the solution of a difficult problem in arithmetic, let him feel that because of this success he is stronger mentally, and that he can achieve greater results. Lead the pupils to apply in their study and in the affairs of the home the knowledge they gain each day in school.

(2) Show that attention means progress and power, and that inattention means waste of time, loss of power and failure in life. Cite the lives of men who, from their prolonged attention to education and to business, rose to distinction. Such men as Washington, Lincoln, Franklin, James J. Hill, and the successful men of the town, county, and state, furnish many stimulating examples.

(3) So far as possible remove distracting tendencies during school hours so that your pupils may fix their attention upon their lessons with the least possible effort. Secondary passive attention is no more nor less than the *habit of attention* strongly developed. A quiet and orderly school, where each pupil may do his work without interference from others is of great assistance in developing the power of attention in the pupils.

(4) Present the subject matter of each lesson in the manner and in the order in which the class can most easily grasp it. Select the vital point in the lesson and by means of story, illustration and practical application, drive it home, then group the minor points around this. To illustrate:

A sixth grade class will find but little interest in Braddock's defeat, but they will be aroused to the highest degree of enthusiasm by the adventures and heroic conduct of Washington on that ill-fated expedition. Therefore, build the lesson around Washington and it will never be forgotten.

9. Interest. Interest is our measure of the value of ideas. That is, we are interested in an idea to the extent to which we feel that it satisfies a mental need. We therefore fix our attention with the least effort upon those subjects in which we obtain the greatest satisfaction. Interest and attention are inseparable. The oft-quoted words of Joseph Cook show vividly the position of interest in a scheme of education.

> Interest is the mother of attention; attention is the mother of knowledge. If you would win the daughter, make sure of the mother and grandmother.

There are two sorts of interest corresponding respectively to passive and secondary passive attention. They are primitive interests and acquired interests.

(a) PRIMITIVE INTERESTS. Primitive interests are those that are directly associated with instinctive desires and impulses. The child is interested in food when hungry, in the sunshine when he feels the need of its warmth, in avoiding the fire when once he has been burned. and in many things that contribute to his immediate pleasure. Primitive interest looks to the immediate gratification of some desire. It is important because it leads to such attention to the needs of the body as is necessary to the preservation of health, and because it leads to acquired interest.

(b) ACQUIRED INTEREST. Acquired interest is gained through active attention, its object is remote and it lies at the foundation of all progress. Acquiring a liking for a new study, as arithmetic, is a good illustration. The child learns arithmetic, not to gratify any immediate desire, but that it may be of use to him in later years. At first active attention, that is, effort of will, is necessary to enable him to keep his mind on the subject, but when he begins to understand that a knowledge of arithmetic gives him a power that he could not possess without it, arithmetic begins to satisfy a desire, and less effort is required to hold his attention upon the subject. Finally, he acquires a decided taste for the subject and delights in its study. His acquired interest has now become secondary passive attention. But we must remember that he has arrived at this stage only through *prolonged voluntary effort*. In a similar manner all of our acquired interests have been "grown into."

(c) EXCITING INTEREST. We have defined interest as our measure of the value of ideas. Each one is most interested in whatever appeals to him most strongly; hence, interest is one of the leading characteristics of individuality. By following the guide of his interests, one becomes an artist, another a musician, a third an architect, a fourth a teacher, and so on. A moment's reflection will enable the teacher to understand the important relation between primitive and acquired interest and how the first naturally leads to the second. The boy draws a picture with no purpose beyond that of making the picture in mind. When he becomes a youth, he studies art for the purpose of achieving greater things in the future. As a man he applies himself to his profession not merely as a means of earning a livelihood, but for the sake of the influence of his work upon society as well.

Some educators have strongly advocated the introduction of play into study, on the theory that whatever appeals to the child in such a way as to satisfy his immediate desires, will secure and retain his interest. In many cases this theory has doubtless been carried too far, with the result that pupils have not been properly trained in active attention, and have consequently failed to establish those acquired interests necessary to a well trained mind. While it is wise to make use of the child's primitive interests at the outset, he should be led from these to acquired interest. School is not play, but work. Concerning this, the following is quoted from *The Educative Process*.

> It is at this point that the function of the teacher is all-important. As far as passive attention is concerned, the child needs no guidance; when he has reached the stage of secondary passive attention, he needs little guidance; but the stage of active attention is the field in which the arts and devices of the teacher find their highest utility. To see to it that the child's development is not arrested on the plane of play is the serious business of education. To determine the point at which the mind must be guided, pulled, or prodded on to a higher plane of functioning is the duty of educational science. But the task of guiding pulling, or prodding is assigned to the teacher.
>
> It is this task that makes the work of the teacher, especially in the elementary schools, so largely a battle against nature. It could not well be anything else. One may seriously doubt whether there is anything innate in the child that will lead him to the increased effort that this implies. Civilization in the race has cost a struggle which the exigencies of the environment have necessitated. No race with whom

the conditions of life were too easy has ever reached the higher planes of development. There is no reason for believing that the civilization of the individual can be accomplished by following the lines of least resistance.

The following suggestions will be found helpful:

(1) Pupils are interested in what interests others. If the teacher shows interest and enthusiasm, the pupils follow her. A bright eye, a dramatic manner, a clear and distinct utterance all attract interest. A divided attention on the part of the teacher will kill the interest of the pupils, who reason well that what will not occupy the entire mind of the teacher is not worthy of their own.

(2) Pupils are interested in action. Do things. Draw diagrams and pictures to illustrate what you say; put something on the board; fold paper to illustrate fractions; show how things are done.

(3) Pupils are interested in things they do themselves. Set them to work. Have them draw, write, solve problems, make the things they read about, model the apparatus they see in action, plant seeds of various kinds and watch their growth. Encourage them to do any good thing that bears relation to their studies.

(4) Questions well framed always arouse interest. Question your pupils often and freely, and encourage them to question you. Never turn away from intelligent inquiry, but welcome it as an evidence of growing interest.

(5) Pupils wish to achieve results, immediate results. Show them frequently what they have accomplished; let them enjoy the thought of progress.

(6) It is impossible, however, to give specific rules for creating interest, because so much depends upon the personality of the teacher and the pupil. If the teacher is a master of her subjects, knows herself and knows her pupils and has an absorbing purpose, she will have no difficulty in finding the devices which secure attention.

(7) Some pupils like to tell what they know; others are interested in what any one says, if he says it well in his own

way. Do not tell, yourself, what your pupils can tell for you. Give them a chance to recite. The more they recite the better they will like it, the greater will be their interest. For the sake of the class don't wait too long for the slow, the lazy and the unprepared. When one has had a fair chance, call on another without repeating the question.

10. Laws of Association. The mind is so constituted that it does not grasp and retain isolated ideas. We understand new ideas by relating them to those already in the mind, and we reject those for which we can find no relation. These relations are established in accordance with well defined laws of association, which depend for their action upon the relations that the different classes of neurones sustain to each other, as already described.

Thorndike in his *Elements of Psychology* states the general law of association as follows:

> The likelihood that any mental state or act will occur in response to to any situation is in proportion to the frequency, recency, intensity and resulting satisfaction of its connection with that situation or some part of it and with the total frame of mind in which the situation is felt.

This law states in concise form the method of establishing associations through the inborn and acquired connections of the neurones. Certain of these statements admit of clear illustration.

(a) RESPONSE. Reaction to the impression is essential to mental progress. It is therefore a fundamental law that every impression results in expression. The expression may take the form of action, as walking towards an object, which attracts our attention, or it may pass to the neurones, upon which it produces definite results. Instead of walking towards the object, however strongly we may desire to do so, we heed the call of duty and remain at our post. The impression has led to no visible expression, but its absorption into the neurones has in some way increased our power to inhibit impulsive action.

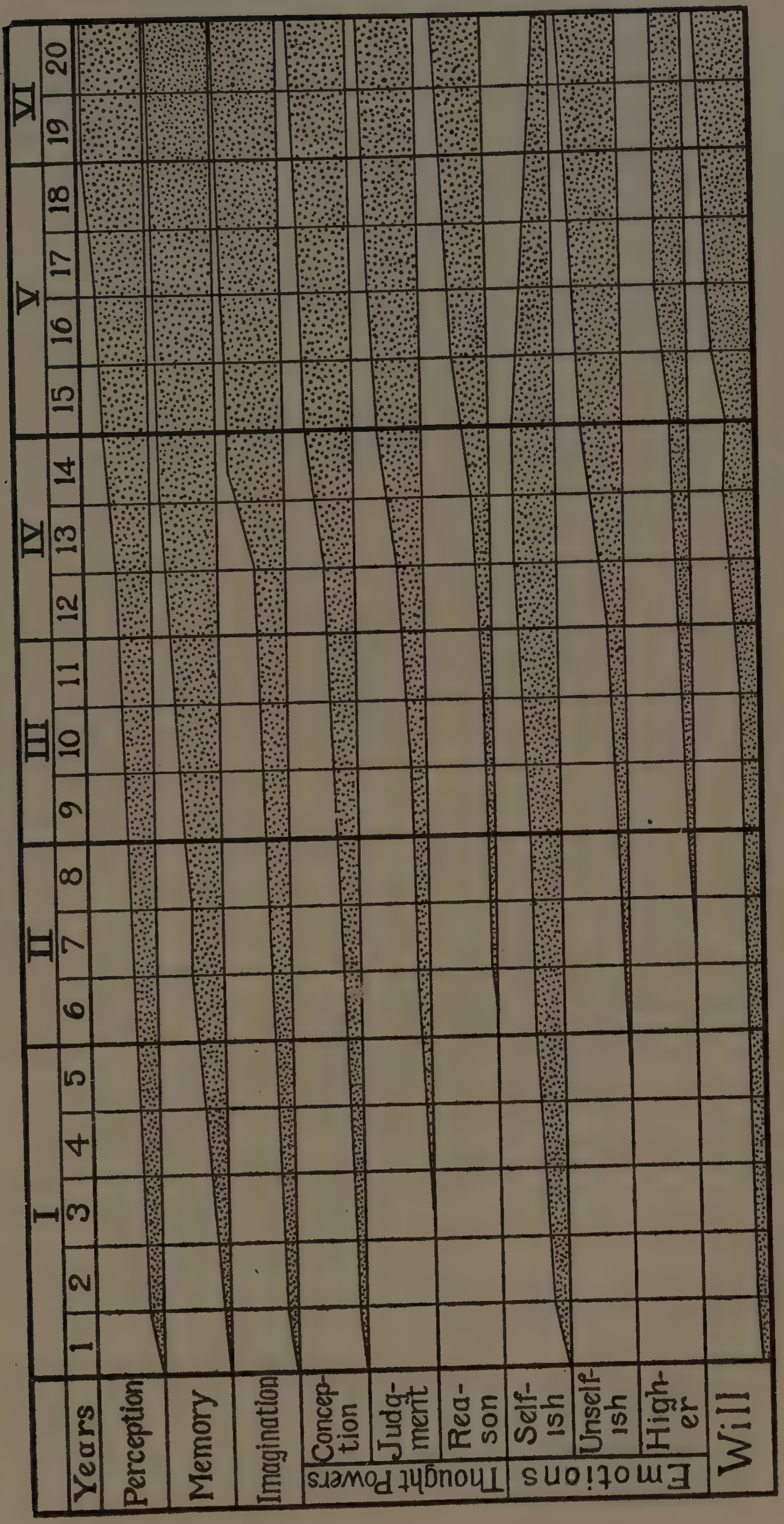
(b) FREQUENCY. Where nervous force has once traversed a given path it acquires a tendency, under like conditions, to traverse the same path again. This tendency strengthened by frequency until finally it becomes a habit. Repetition is therefore one of the best means of fixing facts and processes in the minds of your pupils. But to be of the greatest benefit they should be given at frequent intervals.

(c) Recency. Of two responses to a similar impression, one occurring one year ago and the other last week, the tendency to follow the response of last week is much stronger than that to follow the response of one year ago, when the impression again occurs. It is well to bring facts, principles and rules which pupils have learned to their attention every now and then, that they may hold them "fresh in mind."

The tendency in some courses of study to drop in the intermediate and grammar grades such subjects as arithmetic, language and geography for a part of the year and then return to them, is productive of educational waste. It requires considerable time and much effort for the pupils to recall the subjects, and extended reviews are necessary.

(d) Intensity. The stronger of two impressions produces the stronger expression. You are walking on the street and meet a man who says in a most matter-of-fact way, "I think the building across the street is on fire." You may look at the building for evidences of his statement, but you are not greatly moved by it. Meanwhile another man rushes past shouting, "Fire!" at the top of his voice, and you at once run towards the building. Both men stated the same fact, but you heeded the second rather than the first because of the intensity of his expression.

The practical application of this principle in the schoolroom consists in so presenting the important facts of the lesson that they will make a strong impression upon the pupils. Relate the subject to the pupils' experiences. Make it practical; ask the class to do something at home which will require the application of the principle under discussion. Whenever the subject is such that interesting



DEVELOPMENT OF MENTAL POWERS

This chart shows in a tentative way the relative growth of the mental powers, and the approximate age at which each reaches its normal degree of activity. The Roman numerals indicate periods of development in relation to school life.

stories and poems can be used in connection with it, have these read in class or have the pupils read them at home. Make your lessons vivid, strong and practical, and you will hold the interest of your pupils.

11. Order of Development of Mental Activities. All phases of mental activity are experienced in a complete mental act. To illustrate, you see a horse (observation). By means of the law of association you relate the impression which the eye brings you to one formerly experienced (memory). You compare the two ideas and decide that they resemble each other (reason). From the various ideas of horses that you have in your mind you proceed to construct your ideal horse (imagination). Think this process through for yourself, and you will understand that these phases of activity reach the height of their development in a certain order, which is, in a way, graphically represented in the chart on the preceding page. While this chart is helpful in conveying to the reader a general idea of the state of these phases at different ages of a normal child, we must remember that it is impossible to construct an accurate graphic representation of a mental state. There is no sharp dividing line between one phase of activity and another. All imperceptibly blend into a complete whole. The chief value of the chart lies in its showing what activities are most natural and therefore the easiest for the child each year from infancy to maturity.

If the teacher studies the chart until she understands the general facts of development she will find it a material help in understanding individual temperaments. When in any individual there are marked divergencies from conditions shown in the chart, the teacher will see the necessity of trying to awaken the activities that are backward, in order to secure a symmetrical development. Our interest now centers on the training of these phases of activity, especially through the years that the pupils are in the intermediate and grammar grades. We here make a strong appeal to the teacher to think back to her school days as she reads the pages that follow, and to recall as vividly as possible her own experiences.

12. Observation. The mind is aroused to activity through contact with external objects, and this contact is made by means of the special senses. The powers of observation are those first exercised by the child, and by the sixth year these powers have given him many ideas, but these ideas are crude and incomplete because the mind has not reached the stage of development where it can analyze carefully. When the child enters school, therefore, he needs careful directions. By the time pupils are nine years old they should be so well trained that they can perceive readily things that are brought to their attention. From this time on there should be a marked increase of interest in observation and analysis. The teacher has before her a double problem; to train the pupils to observe carefully and critically the specific object for the purpose of gaining correct ideas, and secondly to lead the pupils to become more competent to observe in fields other than those in which the training is given.

Observation is, therefore, an important means of getting ideas — an important method of learning. Throughout the school course pupils must be encouraged to observe; unless much of the work in the primary grades is based upon careful observation, the clear ideas and images upon which the latter more abstract work should be based will be lacking. It is generally conceded that the poor work in arithmetic so frequently found in intermediate and grammar grades is due to the lack of sense training and observation upon which the number work of the first three years should be based, than to any other cause.

Similar training is necessary in geography and nature study if the pupils are to form correct images for use in the higher grades; hence all through the intermediate grades, concrete illustrations of geographic definitions should be provided. When the class reads about a cape, a peninsula or an isthmus, the object should be molded. In nature study have the objects in the hands of the class. Study the object in connection with the text and the pupils will build their knowledge upon a sure foundation.

13. Training in Observation. In assisting pupils to observe, the following suggestions will be found helpful:

(1) Attention is necessary to observation and attention is based on interest. Excite the boy's curiosity, lead him to observe critically, and let him feel the joy of discovery.

(2) Ideas grow in completeness with the repetition of a sensation. Return, then, in reviews, and in thoughtful repetitions make perfect the faulty or incomplete observations.

(3) Simple things are most easily perceived. Therefore, present few things at a time, and simple things instead of complex ones, or present complex things in piecemeal.

(4) Old ideas sometimes block the way for new ones. We see what we expect to see, not what is there. From this result the illusions so frequent among boys and girls.

(5) Right preparation and apt presentation aid perception. Prepare the minds of the children by exciting curiosity and interest and then present the subject in a pleasing, alert and systematic way.

14. Memory. The function of memory resides in the cerebral cortex, and that portion presiding over each brain center has its own particular memory. For instance, injury to the eyes may cause blindness, but one's visual memory remains, that is, he remembers what he had seen before his misfortune. But if that portion of the cortex presiding over the visual centers is injured, visual memory is lost, and the person is left in worse than outer darkness. Likewise injury to the auditory centers causes loss of memory of sounds. The affected person can hear words but cannot understand them because they have no associations. These and other illustrations that might be given show that there is no special memory center in the brain, but there are psychic areas that are distinct from the sense areas, and it is in these psychic areas that memories may be said to "reside."

Memory, therefore, is a feature of every complete mental act, and the repetition of that act strengthens the memory of it. In the not distant past there has been a tendency among educators to undervalue the importance of memory in a scheme of education. Such a tendency is unfortunate, for without memory all other mental functions would cease. Moreover, we rely upon memory for all our intellectual advancement as we can readily see from our study of the laws of association.

When it is remembered that our most important and significant acts of will are based upon hopes and fears and beliefs which involve calling upon the memory of our past experience, one begins to appreciate how immensely important for all our life history this memory function of the cortex must be. Thus we choose, for example, one course of action rather than another, because we remember that somebody will be benefited if we act this way, or injured if we do not. Memory always operates whenever we deliberate, and anything which would deprive us of memory would effectually destroy the will.

15. Training in Memory. Training in memory involves two problems — training the pupils to remember the facts of the school subjects, and training them to so strengthen this function that they can use it in a larger way in the years to come. The following suggestions will be found helpful in the solution of these problems:

(1) Interest is the mother of attention, and without attention there is no acquisition of knowledge. Present your lessons from such a view-point as will secure the pupils' interest. Interest grows with knowledge, therefore, the more completely your pupils understand the subject the more interested they will become in it.

(2) Repetition increases the modification of the brain cells and makes memory stronger. See that pupils pass over the same ground more than once, remembering, however, that repetition without interest becomes mechanical.

(3) If the mind receives several impressions of the same idea through different channels, memory is intensified. Accordingly, present an idea through as many avenues as possible. Let the pupil in Latin see the new word, hear

it spoken, speak it himself, and note its relation to other words he already knows in English.

(4) Select the central point in each lesson and place special emphasis upon it. When too many things are presented at once, the pupils become confused, and remember nothing distinctly. Train your pupils to study in this way so that they will retain at least one clear idea from each lesson.

(5) Ability to recall is the all-essential feature of memory. Ask pupils daily to recall the facts and experiences of previous lessons, to tell you what they read, to describe what they see on the way to school, what they do at home, what friends they meet, and anything else that will keep the memory function active.

(6) Things that are done are remembered better than things that are read or merely thought. Have pupils construct problems in arithmetic, prepare original sentences to illustrate principles in language, give oral and written descriptions from their reading — in short put action into everything they learn in school.

(7) We recall ideas through association. Children establish relations of time and place, similarity and contrast; adults, who have the function of memory properly developed, recall ideas chiefly through the association of cause and effect. It is the duty of the teacher to lead the pupils so to classify their knowledge that they will come to depend more and more upon the relation of cause and effect in recalling ideas. It is the man with the logical mind, the one who can reason, that is able to recall readily the knowledge applicable to the case in hand.

(8) All the foregoing suggestions will be of no value unless your pupils get clear ideas as they pursue their studies. Close observation and the formation of clear-cut images are essential to good memory.

(9) The memory function is weakened by fatigue. We are unable to recall past experiences when weary, and school programs should be so arranged as to place those recitations

that tax the memory, at times when the pupils are free from fatigue.

(10) For both teacher and pupils here are four good rules for training memory:

(a) Interest yourself in the thing you wish to remember.

(b) Allow nothing to distract your attention.

(c) Associate in as many ways as possible the new idea with old ones already fixed.

(d) Recall the fact frequently, after intervals of other thought.

16. The Imagination. By means of the imagination we construct mental images of things as we want them to be, or as we fear they exist, instead of as they are. All the great works of art and literature, all inventions and laws upon which civilization has depended for its progress are due to the imagination. The pleasure derived from anticipation, our contentment and happiness under the conditions under which we live, and the horrors of worry and fear are likewise due to this same power of the mind.

"In Syria, India or Egypt sought,
One answer only have the years
Sent down to banish doubts and fears:
Within Thyself must Heaven be caught
And captive held — or all is tears!
For this saints died and martyrs fought."

"Thyself within! Thyself within!
O friend! find here thy strength, thy peace.
Pray not that loss and change may cease —
Pray, rather, higher heights to win!
Thy spirit Godward wings release,
And soar thee where thou art akin!"

The tendency to form mental images becomes active in the early life of the child and it is one source of the enjoyment which the child derives from his play. It is also through this power that he revels in his world of "make believe." Since at this age ability to make judgments and to reason as adults is weak the child is prone to make astounding statements concerning his experiences.

Teachers and parents should not be disturbed by these statements for in due time they will be corrected, unless by frequently calling attention to them we seem to emphasize their importance.

The image-forming power of a boy or girl of twelve is active; in two years it is far more active, and from that time on to maturity it increases in power and vigor. The twelve-year-old revels in imaginative literature, but the youth furnishes his own marvels. When this activity is under the dictation of another, we may call it receptive; when under control of ourselves, creative. The child's imagination is receptive; the youth's, creative. The older boys and girls with whom we deal have already formed ideals for themselves, and those ideals are just as forceful to them as the higher ideals of adults. So far, the experiences of children have been largely with material things, and we have no right to expect lofty ideals, for the mind can build only from what it has in its possession. Imagination is the basis of originality, the great creative activity that makes the mind peculiar to the person. Regarded thus, and not erroneously as a sentimental phase of mental activity of advantage only to the story-writer or the artist, its proper care becomes of highest importance.

17. Training in Imagination. (1) The imagination works upon the materials given it, be they good or bad. Supply the mind with elevating images of literature, history, biography and art. Teach what to read and how to read it.

(2) The imagination grows by use. Encourage your pupils to recall past experiences and form distinct mental images from them. In arithmetic, after problems have been solved by the aid of drawings or construction work, and are fully understood, have the pupils recall the images of the illustrations used the day before and solve the problem again with these images in mind. In geography, have pupils draw maps from memory, then compare their drawings with a perfect copy, and in this way correct their images. In history, ask them to form mental pictures of

the dress of the early colonists, of the interiors of their homes, and of the minute men who rallied at Lexington and Concord.

Let the older pupils form images of Eli Whitney inventing the cotton gin; of Stephenson and his locomotive; Fulton and his steamboat. Take them into the realm of literature and let them image the scenes in *The Village Blacksmith*; *Paul Revere's Ride*; *In School Days*; *The First Snowfall*, and many other choice selections. Ask them to write imaginative letters from foreign lands; encourage them to write stories; to design ornamental borders for the blackboards — in fact, to do any worthy thing that calls for the use of their inventive powers.

Plays and games, especially those in which children can engage in the open air, are of great value in developing the imaging function along healthy lines, and should be encouraged by all teachers.

(3) A too vivid picturing imagination may be hurtful; whenever possible, give a practical turn to the inventive powers. Do not let the pupils become dreamers and visionaries.

(4) The imagination may revel too freely in great and exciting experiences and so make its owner discontented and weak in meeting the trials of life. In this way are liars often made. Keep the imagination near the earth; show the pupils the beauty of contentment, the necessity of making their own way, of doing daily the things they dream.

(5) Evil sights, sounds or thoughts are material for corrupting the imagination which may lead to terrible consequences. Evil deeds will be detected or punished; evil imaginings may corrupt a whole life and extend their evil influence among a hundred pupils. Teach that the person who sins openly may be less dangerous to himself and others than the person who dwells on secret and improper thoughts. Try to displace evil thoughts by constantly suggesting and by dwelling upon pure and high ideals.

Create a taste for good literature by supplying good reading suitable to the ages and tastes of the pupils.

(6) Watch for indications of moodiness and the working of unhealthy imaginings. Wake up the dreamers, cheer up the discouraged and the despondent.

18. Thinking. Whenever a problem presents itself for solution, we bring into consciousness all the knowledge we possess which seems to have any relation to it. We then begin to compare the facts and ideas which we previously obtained with those presented by the problem and decide which elements are like those it includes. These we retain to aid us in our solution and the others we dismiss. Through this process of recalling and comparing our past experiences with the present one, we arrive at some solution of the problem before us. The solution may be incomplete and it may be wrong, but such as it is, it is the best we can do with the knowledge at hand and our ability to make comparisons and draw conclusions.

To illustrate: A boy has caught a bat and brings it to his teacher with the question, "Is this a bird?" If the teacher is wise she will assist the boy to answer his question for himself by leading him to take the following steps:

(a) CLEAR THINKING. The bat is the object under consideration and the boy must think the bat, not a mouse or a frog; that is, he must hold clearly in mind the object under consideration. Moreover, he must examine the bat with care and obtain clear ideas of its different parts, and these ideas must be ideas about the bat, not about any other animal, otherwise he will not be able to answer his question.

(b) DISTINCT THINKING. It is not enough that the boy think of the bat alone. He is trying to answer his question, "Is the bat a bird?" He must now bring into consciousness his idea *bird* and compare the two ideas, that is, he must think the thing (bat) in its relations. He now has both ideas in mind. Are they alike? Before he can answer this question, he must take the third step, namely:

(c) ADEQUATE THINKING. Adequate thinking is thinking the thing in its essential parts. The boy must now compare the bat before him with his idea *bird*, part by part. Are the bodies alike in form and structure? How does the covering of the bird compare with that of the bat? Look at the bat's head; its mouth. Does the bat have teeth? Does the bird have teeth? Does the bat have wings? How many legs does it have? It is only by such a careful comparison that he can arrive at a correct answer to his question. In other words, he must think adequately, or his conclusions will be faulty.

Such a train of thought as we have outlined should lead the boy to the conclusion that the bat is not a bird. This conclusion naturally gives rise to another question. "If the bat is not a bird, what sort of an animal is it?" Or, as an adult would put the question, "What is the bat's position in the animal kingdom?" This question the boy may not be able to answer until he has studied zoology in the high school; but the answer is necessary to satisfy the boy's curiosity, and finding it leads to the fourth step, in which the boy will need a good deal of assistance. This step is:

(d) EXHAUSTIVE THINKING. In order to determine the bat's place in the animal kingdom, one must have such knowledge of zoology as will give one a clear idea of the different orders of animals, and must be able to compare the bat with the idea of each order as it is held in one's consciousness. In this comparison minor characteristics must be rejected, and only those general characteristics upon which broad classifications are based be held in mind. Before such distinctions can be made one must be able to reason accurately from cause to effect. This thinking the thing in its relations of cause and effect is exhaustive thinking. It is often known as pure reason. Exhaustive thinking is the highest activity of which the thought powers are capable. It enables us to project our knowledge into the future, and from our past experiences to form conclusions which determine our future action. It is upon this sort of thinking that all progress in science, invention and discovery depends.

19. Training Pupils to Think. (a) CONCEPTION. (1) The first step in thinking consists in comparing ideas of simple objects and deciding whether they are like or unlike. Upon these decisions the child begins classifying his ideas. To this step the name *conception* is often given, and the ideas formed are known as *general ideas* or *general notions*. They are represented by common nouns, as *cat*, *man*, *tree*. The child's first thinking is of a very general nature. Since he cannot observe closely, he cannot classify accurately. He at first notices only the most striking points of resemblance and difference in the objects compared; more accurate observation and closer analysis come with the development of his powers. It is therefore unwise to ask pupils in the primary and intermediate grades to make fine distinctions.

(2) Pupils in the intermediate and grammar grades are interested in simple facts of classification among plants and animals. The evident characteristics that make sparrows *finches*, and orioles *blackbirds*; that make hepaticas *crowfoots*, and strawberries *roses*; that make tigers *cats*, and wolves *dogs* — these are the facts they enjoy learning by analysis and comparison, and from which they make their conceptions of families and genera.

Therefore, dwell on classification in lessons in elementary natural science. Do not try to make fine distinctions or to make the classifications for the pupils. The boy who can discover for himself that the oriole must belong to the family of blackbirds has not only formed a valuable concept but he is learning to think. Geography is the one regular study of the period that offers the best opportunities for classification.

(3) There can be no real conception without perception. Therefore, the giving of definitions and classified tables will not stimulate scientific concepts. If the pupils themselves make logical outlines and construct clear-cut definitions, the

action is invaluable. Reading and history furnish material for excellent practice in outline-making, as do language and arithmetic in the making of definitions.

(4) Observation, memory and imagination are all necessary to thinking. The child must gain ideas first hand; he must be able to recall these ideas and to recombine them into new mental images which will have the relations he wishes to establish. See that the number facts learned in the primary grades are founded upon actual experiences of the pupils. Have them construct their tables in addition, subtraction, multiplication and division first by the use of objects, then by the use of figures. Follow a similar plan in teaching language, geography and in the nature study lessons. Clear ideas lie at the foundation of clear thinking, and the teacher should satisfy herself that her pupils are acquiring this sort of ideas. The imagination is indispensable in the formation of general notions, but it must be kept within the bounds of reason and held to facts, in the formation of new ideas, otherwise these images will not be true.

(b) JUDGMENT. (1) Any conscious solution of a problem determined by past experience is a judgment. A judgment takes the form of the proposition *A is B*; *the cat is an animal.* Judgments may be classified as specific and general. In the formation of general notions from individual notions we use simple judgments, as, the rose is a flower, the hat is red, etc. As we have already shown under (a), the formation of these judgments is the first step in thinking.

(2) The teacher should see that the process does not stop here. In the formation of these simple judgments the pupils must be led to pass from the concrete to the abstract. Objects are necessary, for instance, to give the pupils clear concepts of number facts, but if they depend upon objects too long they will make but little progress. They must pass from thinking in things to thinking in symbols.

The too constant use of blocks however valuable at first, ultimately begets blockheads, instead of intelligence capable of the higher life of thought and reflection.— Schaeffer.

(3) Simple judgments lay the foundation for those broader judgments through which we predicate agreement or disagreement between large classes of objects. "This animal is a cat" is a simple judgment, but the proposition, "All cats are quadrupeds," is a general judgment because it predicates agreement between two classes instead of between an individual and a class. This distinction should be carefully noted by the teacher, for it lies at the foundation of the distinction between particular facts and general principles or laws.

By the beginning of the intermediate years the boys and girls have begun to make clear-cut judgments of large relations and to hold very strongly to the judgments they have made. By the time they leave the grammar grades their power of judgment should have become well developed and they should be able to recognize the truth or falsity of a proposition within the range of their experience.

This experience, too, widens rapidly during the years from twelve to fourteen, and at fifteen a boy or girl has powers of judgment that many teachers fail to realize.

(4) Every judgment is a thought, and if thinking is to be right, judgments must be clear and correct. False judgments may arise from mistaken notions of fact and from other causes. Perception, memory and conception enter into every judgment, and if any one of these elements is imperfect, the judgment made upon them will not be true. For instance, if a person has not a perfect perception of the length of a foot, all his judgment of lengths in that unit may be defective; if he cannot remember who threw the stone, he cannot tell who was guilty of breaking the window; if his conception of either stealing or of crime is imperfect, he cannot clearly judge that stealing is a crime. But there are other causes of indistinctness or error in judgments that are not so freely recognized by the teacher

but that are no less fatal to clear thinking. Feeling powerfully affects judgment. An angry boy or girl is incapable of judging truly; under the influence of his feeling he may be convinced that his teacher is his personal enemy, while in calmer moments he may actually approve her action. Any form of excitement clouds the judgment. In a close game of ball the players and spectators may become so excited that they will bitterly accuse the fairest umpire of dishonest partisanship. *Freedom from excitement is essential to clear thinking.*

(5) Judgments are the mental products of those who form them. Those found in books are *dead* until they become the real living experiences of those who read them. One of the most deplorable causes of indistinctness is the facility with which people accept the judgments of others. However necessary it may be for children to be guided by the judgment of their parents and elders, there comes a time when every person must rely on himself. Too often the schools do little more than train the pupils to accept the judgments of others and send the young people away with minds full of the hazy judgments they have gained from text-books and with no real power to discriminate clearly and wisely. Teachers who have control of pupils whose reasoning powers are just coming into use carry the responsibility of making their students independent thinkers. To start them right is to send them half way on the road. It is the chief scholastic duty of the teacher in upper intermediate and grammar grades.

(6) Truth is of the greatest importance in forming judgments. Therefore, be exact in your language and require exactness from your pupils.

(7) When it is the judgment you wish to train, do not tell the pupils too much. By means of questions lead them to see true relationships, to become self-critical, to correct their own errors. Do not befog them with many details. Stick to the essentials and lead the pupils to see what is essential.

(8) Keep the pupils thinking vigorously while they are at work. Lead them to see the pleasures of thought and make truth seem of more value than anything else. "Is that true?" and "How can you show me the truth of that?" are the questions that should be asked most frequently.

(9) Keep the mind free from prejudice, which is the fixed habit of allowing the feelings to sway the judgment. Make the thinking boys and girls realize the importance of calmness in thought, and that the judgments they form in passion are probably more or less faulty.

(10) Children and youth are prone to hasty judgments and to conclusions drawn before all the facts are known. Check this tendency by constantly pointing out errors and their causes.

(11) Discourage reliance on the judgments of others. Allow always the respectful questioning of your judgment by the older pupils. Encourage them to question statements in their books if the statements seem untrue or illogical, but do not allow the habit to degenerate into petty quibbling or to make doubters out of believers. Truth will stand honest questioning.

20. Reason. In formal reasoning we compare two propositions with a third and from this comparison draw a conclusion. From the view-point of pedagogy the chief difference between reason and judgment lies in the fact that reason involves more explicitly the process of inference; that is, from effects of known causes we infer that these causes will produce the same effect wherever they may operate. To illustrate:

You live in 45° n. latitude and at an elevation of 2,000 feet above sea level. The region in which you live has winter from the first of December until March. The snowfall averages four feet for the season. The mean temperature is 30° F. What is the winter climate of a region similarly situated south of the equator? You infer that this place must have a climate closely resembling that of the region in which you live. Following this conclusion you resort to some work on geography to verify it. If you find your conclusion to be incorrect you look for the fallacy in your inference and discover that some conditions in the second locality are different from those about your home. Not knowing these conditions, you did not take them into consideration.

Correct inferences can be drawn only when all the facts are known, and those who attempt to draw them without sufficient knowledge usually fall into serious error.

21. Training in Reason. (1) As reason is feeble in the early intermediate grades, the boy or girl must be called upon to make easy inferences only. Arithmetic furnishes the opportunity for simple inferences, for asking the reason, the *why* of things. The great question for reasons is, "Why is this so?"

(2) Nothing but the use of reason can make it grow. Therefore, see that children *do* reason; guard against their always accepting the reasons of others. Learning reasons is not reasoning, but a destroyer of reason.

(3) Progress in reasoning must be slow. Accordingly, do not expect too much: be content with very obvious reasons at first.

(4) Use attractive methods to lead the pupils to look for the reasons for things, and to say, "Because of this and this, that is true."

(5) Test inferences by facts and lead the pupils to see the errors in hasty inferences, the danger of making conclusive inferences from few facts. Because nettles have stiff hairs and sting badly, it is not safe to infer that all plants having stiff hairs will sting.

"At learning's fountain it is sweet to drink,
But 'tis a nobler privilege to think.
And oft from books apart, the thinking mind
May make the nectar which it cannot find.
'Tis well to borrow from the good and great;
'Tis well to learn; 'tis Godlike to create."

22. The Feelings. The great English psychologist Sully tells us that feeling is any state of consciousness which is pleasurable or painful. Our likes and dislikes, pleasure and pain, desires and aversions constitute our feelings, and we express our feelings through our acts. We are unable to master our feelings as we do the activities previously discussed, for the purpose of acquiring knowledge. They often master us. We can, however, by continual effort keep them under control. Feelings are rythmic in their action, increasing until they reach their height, then subsiding. Thus love and anger rise and fall like the waves of the sea.

23. Training the Feelings. (1) The child is born with certain tendencies which lead to his first acts. We call these acts instinctive. It is generally thought that they are impelled by conditions of the body, as hunger, thirst, muscular strain, etc. These instincts are closely associated with the emotional phases of life which take on more definite form as the child grows older.

(2) The feelings, like thought, arise whenever a problem is presented for solution. The desire to master the situation impels us to action. If the desire is very strong we may take the first "short cut" that presents itself, and find, when it is too late, that we have blundered. The desire (feeling) causes us to look at the end sought without giving careful consideration to the best means of securing that end. On the other hand, as soon as we begin to think about the problem we begin to plan a course of action which will lead to its solution. To illustrate:

A hungry child sees a glass of milk on a shelf which he cannot reach from the floor. In his eagerness (excessive feeling) he tries to get the milk by jumping up to it. After several attempts convince him that he cannot succeed in this way, reason asserts itself and he gets a chair, climbs upon it and gets the milk. Desire impelled the child to action, but he had to think out a plan for solving his problem before he could reach the end sought.

The feelings of children are lively and dependent more completely on physical sensations than those of adults. Childish emotions are fiercer for the time being and not under control of the will. Upon the teacher of the upper intermediate and grammar grades, then, falls the duty of educating the child in the emotional crises of his life. The struggle between the self-centered and the altruistic emotions is often a fierce one and almost always about the age of puberty there are wild, almost ungovernable, impulses, unsteadiness, stolidity, lack of enthusiasm, and stormy outbursts. The wise teacher knows that these troubled days will pass away and calm succed the storms. To pilot the boy and girl through these crises is the highest privilege of the teacher, the duty which calls for the keenest sympathy, the finest discrimination, the greatest tact.

(3) Success brings a feeling of honest pride and joy. Help the children to succeed, to realize that sturdy effort wins.

(4) Independence brings satisfaction. Help the children to act fairly independent of your authority. Do not browbeat them into angry submission or frighten them into moody acquiescence.

(5) Humiliation causes a loss of self-respect, and self-respect is the keynote of character. Avoid belittling the efforts of anyone. Make much of the sense of honor and right.

(6) Sympathy is the basal altruistic emotion. Lose no occasion to encourage in every pupil a sympathetic interest in others, a wish to help the needy, to comfort the suffering. Give polite behavior and generous acts your hearty approval, and condemn rudeness and selfishness.

Sympathy, the foundation of all the altruistic feelings, means more than the sentimental expressions of good will. One becomes sympathetic through a sympathetic service for others. But the giver of sympathy is the receiver also. Every genuine feeling of sympathy for the misfortunes of another reacts to the happiness of the sympathizer. Experience declares that giving affords more pleasure than receiving. — Gibbons.

That man may last, but never lives,
Who much receives, but nothing gives,
Whom none can love, whom none can thank,
Creation's blot, creation's blank.

(7) The love for knowledge is the first of the higher emotions. Show your own love for knowing, show some enthusiasm over a good solution of a problem, a piece of accurate observation, a well written composition. Show the baseness of ignorance, not by personal application to one of your pupils, but in general ways.

(8) The love of beauty is the first of the aesthetic emotions. Beauty is everywhere around you — in the flowers and trees, birds and insects, sky and water, in pictures and statuary, in poems and stories. In one form or another it will appeal to each of your pupils. Make a practice of saying, "Isn't that beautiful?" and add a few words to show why it is beautiful to you. Watch for responsive interest, and when you have found it encourage that particular pupil in the way he seems inclined to go.

(9) Joy in duty well performed is the highest of the moral emotions. "Is it right to act thus? If it is, then I owe it to myself to act thus; it is my duty." Such is the form of reasoning that leads to the sense of duty. Ask these questions often: "Do you think you are acting right?" "Do you think you ought to do that?" Be content if you see slow growth in this sentiment. Be sure the pupil thinks over your question candidly and then accept his judgment, if you can, even though you do not fully approve of it. Try to have every right sentiment of duty carried out into action. "If you think you ought to do that, please do it." Be sympathetic with failures and encourage to renewed efforts. Thus is conscience developed.

(10) Praise gives pleasure. Praise rather than blame, but praise discriminatingly. Flattery breeds the ugly forms of self-esteem, conceit and selfishness.

(11) Inspiring literature is one of the best aids in training the emotions; use good fiction, noble poems, good essays.

24. The Will. The will directs our attention, leads us to deliberate and impels us to action. Attention, choice and action, then, are all included in a complete act of will. Will acts in response to feeling. We desire this or that, decide to obtain it and act in accordance with our decision or choice. Since our choices determine our character the teacher should use every means possible to influence her pupils to make right choices. The first choices made by the child are due to instinct and impulse, but gradually he acquires the power to make deliberate choices, and during the time spent in the intermediate grades this power develops rapidly. During this period the teacher should be chiefly concerned with choice and action as will factors.

25. Training the Will. (1) Choice is the chief function of the will. Therefore, pupils must be given opportunities for choice, and led to make the right choice. Every time a child decides between two alternatives in respect to his conduct or his work, he exercises his choice and strengthens his power to choose.

(2) Action fixes the will. Every time a boy adheres to his choice and acts in accordance with it, he strengthens his will.

(3) Hard study at regular intervals compels choice, attention and action, and trains the will effectively. Lead your pupils to choose, in study hours, to drive away distracting thoughts and to persist in the effort till the time is up.

(4) Hasty action does not give time for choice. Discourage action from impulse. "Think before you act"; "Think before you speak," "Think what you mean to do before you begin on the solution of the problem." "Would you have acted in that way under the same circumstances?"

(5) Every temptation resisted helps the will. Show the boys and girls where temptations lie and help them to resist them. Do not suggest the possibility of failure. Insist that anyone can, if he will.

(6) Control from without weakens the will. "You must do this," is a bad command for will-training. "You ought to do it" and "Won't you try to do it?" are better suggestions to make. The interests of the school may some-

times demand stern control. Occasionally the individual may need it to prevent some unlawful act, but he will not profit by it until he has been led to see the justice of it and to determine to avoid the offense in the future.

(7) Some children are positive and wilful by nature. It is not the teacher's function to break the will, but to bend and influence it to become a tremendous power for good. It is the doing that really counts. Encourage every pupil to carry his determinations into acts. Doing makes habits. We are dealing with the great habit-making epoch in life.

TEST QUESTIONS

1. Why is a knowledge of psychology necessary for efficient teaching?
2. What vital relation exists between the mind and the body, and how do they act upon each other?
3. Why should the teacher understand the laws of brain development?
4. What is meant by the "localization of brain action"?
5. What is the importance of attention in school work, and how can the teacher help her pupils acquire attentive habits?
6. Discuss the relation of interest to attention.
7. How should the teacher make use of her knowledge of the orderly development of the mental powers?
8. How does training in observation aid in the study of arithmetic, geography and nature study?
9. State the fundamental rules for memory training.
10. Of what practical value is the development of the imagination?
11. What is the foundation of the power to reason clearly?
12. What is the importance of training the will?

CHAPTER TWELVE

PRINCIPLES AND METHODS OF TEACHING

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1. Dependent upon Laws of Mental Development. In the preceding chapter we have set forth the relation of the nervous system to mental activity, and the order in which the mental powers develop. We have also stated the fundamental laws of mental activity and given suggestions for training the powers of the mind. The ability of the teacher to present instruction in accordance with these laws and principles is, in a great measure, her ability to succeed in her chosen vocation.

2. Growth of Knowledge. Knowledge grows from the activity of the mind and in no other way. It is only when the pupil teaches himself that he makes progress. The teacher is merely the guide or leader. To remove all obstacles from the way of the learner is to weaken his progress, for it is only by surmounting difficulties that he gains strength. Yet when the problems are too hard, the obstacles too difficult, the person becomes discouraged, and his mind ceases to work. The teacher must discriminate wisely and then give just so much assistance as will stimulate to highest exertions. Again, overwork brings fatigue to the mind as well as to the body, and the teacher must check her pupils when they show signs of failing power. Self-judgment and self-criticism are invaluable aids to mental progress.

3. The Process of Learning. A complete act of learning includes all the phases of mental activity. In many instances the act is completed in such a short time that it would seem that these activities all occur together. But a study of the act when applied to a case requiring time shows that they follow each other in a general order. This is best understood by considering a concrete case.

A girl, walking in the woods, found a flower which she had never before seen. Its peculiar appearance at once attracted her attention and she had a desire to know what sort of a flower it was. She had some knowledge of botany, and determined to find the family to which this flower belonged. Her method of procedure was as follows:

(a) ATTENTION. The peculiar appearance of the flower at first attracted her attention. This attention at once becomes active and she examines the flower.

(b) INTERPRETATION. In the course of her general examination she brings into consciousness her knowledge of plant families, and tries to decide to which the new flower belongs. Before she can settle the question, however, she finds that she must make a more minute examination. Her next step therefore is:

(1) *Analysis*. The girl now takes her botany and examines the flower part by part as she studies the key to the flora, until she finds the family to which it seems to belong. She has now taken the flower apart, or analyzed it. Having found in the key to the flora the supposed family, she takes the next step:

(2) *Synthesis*. She now turns to the description of this family in her botany and proceeds, as it were, to reconstruct the flower in accordance with this description, part by part. She finds that in all the essential parts the flower agrees with the description; hence she decides that it is a lily.

(c) USE. The term *lily* now means more to the girl than ever before. Whenever she walks among wild flowers she is observing them to determine whether or not they are lilies, that is, she is using the new knowledge she has gained and is, in this way, fixing it more firmly in her mind.

The above is a typical illustration of what occurs in every act of learning, but in some acts the process is shortened because of our past experiences. A botanist would have decided at the first look at the flower that it was a lily because he had already formed a distinct mental picture of a lily. So in the daily work of the school some new ideas arise that are at once interpreted by past experiences, while others require careful analysis and comparison with these experiences.

The successful teacher always recognizes these steps in the process of learning, and leads her pupils to take them in their natural order. We suggest that the reader make a careful study of this illustration, then apply it in learning some new idea and bear it constantly in mind in presenting new ideas in all branches in the schoolroom.

4. Maxims of Teaching. The following maxims are applicable to instruction in all grades, though some of them become of less importance as the age of the pupils increases. Familiar and almost trite as these are, no teacher can afford to neglect them, and there is no more profitable food for reflection than the application of these same maxims to the exigencies of the day.

(1) *The Concrete Precedes the Abstract.* Manifestly this is strictly the order for children, but boys and girls who have begun to have some power of abstract reasoning may well reverse the order. Even in geometry, in which the order is naturally reversed, concrete presentation often aids the understanding, and the elements of the subject are best presented concretely. We might say that the introduction to new subjects and the difficult steps in all subjects should be presented with an abundance of objective illustrations. The teacher can tell when the pupils are progressing understandingly, and if she sees them losing themselves in the mazes of abstraction she will bring them back to real things again. On the other hand, when pupils find the

illustrations unnecessary or silly, she will abandon them and push abstract reasoning to the limit.

A word of caution may be necessary at this point. In the process of learning, *concrete* and *abstract* are relative terms. What is abstract to one may be concrete to another, and what is abstract at one time may be concrete at another. To illustrate: The Figures 4, 5 and 6 have no content or meaning to the child until he has learned by the use of objects what they represent. Until this step has been taken they are abstract. He may learn the names associated with the respective symbols so that he can name each figure as it is shown; but the name has no significance beyond the character to which it applies. If the child is led by the use of objects to understand the meaning of these symbols they always stand for the respective number facts which they represent.

The teacher, however, has passed beyond this stage, and to her the figures stand for number facts regardless of any groups of objects; in other words she thinks them as relations or in the abstract, and to this stage of thinking the pupils must in time be brought. We begin with the concrete, but, if well done, our work will lead to the abstract.

(2) *Proceed from the simple to the complex.* This maxim is always applicable, because of the varying values of the words *simple* and *complex.* What is complex to the pupil this year will be simple to him next year. Many things perfectly simple to the teacher are highly complex to the pupil. What the maxim means is that instruction must be kept within the understanding of the pupil. Teachers of little experience are liable to overestimate the power of their pupils and to present too difficult subjects. The result is always imperfect understanding and ultimate discouragement and dislike. On the other hand, where things are made too simple, the pupils become enervated, lazy, and without ambition to conquer. Normal boys and girls do not like to be babied and strongly resent having things simplified for them.

Those facts which the child can most readily interpret through his past experiences are simplest to him, although they may be of decidedly complex nature from the viewpoint of psychology. The letter *A*, for instance, is more simple than the sentence, *My dog can run*, but the sentence is simpler to the child because he knows that a dog can run. Children in the first grade are therefore taught to read more readily by the use of familiar sentences than by the use of the alphabet.

(3) *Go from the known to the related unknown.* This maxim is an outgrowth of the doctrine of apperception, which holds that the mind assimilates knowledge or interprets new facts by means of those ideas which are already in the mind. When a new idea presents itself, we may assimilate it at once, but if it is quite foreign to anything we have previously known it may take time to apperceive it, for we must cast around in our minds for something related to it. If this related something cannot be found, the new idea never becomes a part of our knowledge and experience.

This maxim is one of the most important that governs the intermediate and upper grade work. In geography, in reading, in science, the pupils are progressing so rapidly, are having thrust upon them so many new ideas that the whole mental state will be one of confusion and haziness, unless great care is taken. With every new subject, in every reading lesson, the teacher must show relationships, must tie the new knowledge to the old.

(4) *Facts should precede definitions or principles*; *processes should precede rules*. This maxim needs but the one comment, viz., that the obvious method is not always the best. Although following the maxim in general, the teacher, nevertheless, sees that the older her pupils grow the less necessity there is to adhere strictly to the principle. She sees, too, that to adopt the maxim literally would be to make each child traverse the mental pathway of his race and prevent him from profiting by the wisdom of his prede-

cessors. In mathematics, in science and elsewhere, we must accept many principles as established, many rules as being too well known to need demonstration. So much time is often saved by working by rule that we cannot always afford to try to learn the processes by which the rules were obtained. For instance, it would be absurd to withhold from the boy in arithmetic the law that "the square on the hypotenuse of a right triangle is equal to the sum of squares on the other two sides," until he becomes able to derive the law from his own reasoning. However, the fact may be made very clear to him by ocular (concrete) demonstration.

The maxim discussed in the above paragraph resolves itself into this: Should a pupil be kept in ignorance of a rule or procedure until he is able to understand the reasons for it? The question is an important one to the teachers of rural schools, especially those schools which have pupils who are fifteen or sixteen years of age, and who probably will never attend any other school. Good judgment would indicate that in such cases practical rules may be thoroughly taught in such a way as to give these pupils methods of work which will enable them to do more than would be possible if these rules were deferred until every step upon which they are founded is reasoned out. The success of some of the most widely known correspondence schools which adhere to this plan of instruction also bears out this opinion.

5. Analysis and Synthesis. Analysis, as the word is used in our theories of teaching, means that mental process by which qualities are separated and identified. To take the cover from the ball, unwind the yarn, and disclose the hard rubber core would not be analysis, but to determine that a ball is round, smooth, white, hard and elastic is to analyze it. There can be no apprehension of anything unless certain of its qualities are held prominently in mind, and the thing is to that extent analyzed. However, we do not indulge in this process for its own sake, but rather to understand the nature of an object or an idea. Before we can understand the whole which we have analyzed we must again put together the qualities we have determined. Having analyzed a ball, we unite the qualities and think that an object which has roundness, smoothness, whiteness and elasticity is a ball. The latter process is called synthesis. By further analysis we find more qualities, synthesize them with the ones we have already determined, and gain a clearer, more definite idea of a ball. The two processes always go together and cease only where the synthesis is complete. (See illustrations under Section 3, *The Process of Learning.*)

6. Method. Among the writers on educational topics the word *method* is used with a variety of meanings, and the result has been to cause no little confusion among teachers. Method is the systematic way of doing things under the guidance of established principles. Note that in teaching, the principles are the immutable laws of mind and not the formulae laid down by individuals. Method cannot be created; it can only be discovered. The person who in his teaching follows systematically the principles of mental growth which we have discussed in the preceding chapter is using method.

Method may be applied to a great variety of conditions and circumstances and by thousands of individuals. The manner in which method in teaching is followed may be as varied as the subjects presented, the pupils taught and the teachers who instruct. We have methods in reading, methods in language, methods in geography and in practically every other subject in the course of study. Their value depends upon their conformity to the process of learning, set forth in Section 3. Devices are those schemes employed to attract attention. Many of them are good, but they should be used as a means to an end, that is, to lead the pupils to take a permanent interest in the subject. The teacher who begins and ends with devices is a failure. Often a device which on the surface seems attractive and effective is found to be worthless because it is in violation of the laws of method. Devices and methods must always be tested by the laws of mental activity. The two general methods in education most frequently treated in works on pedagogy are the *inductive method*, and the *deductive method*.

7. The Inductive Method. The inductive method proceeds from the individual to the general notion, or from separate ideas, gained through observation, to definitions, rules and classifications. It is also called the observational method and the method by discovery. Children obtain their first knowledge by observation and experience; hence they learn inductively, and from the comparison of ideas thus gained they form certain conclusions or class ideas, such as all dogs have four legs, fire is hot, ice is cold, five and five are ten. In nature study the child proceeds through the examination of single plants and insects and other objects to discover certain facts common to all the objects of each class, as, that plants have leaves and insects have heads and legs. In the study of geography by the inductive method, the pupil would begin with the study of objects immediately about him, such as the forms of land and water and the plant and animal life around the schoolhouse and in the neighborhood. From this he would proceed to the study of the township and the county. During the progress of the study he would be led to classify and name those objects that are alike, such as hills, valleys, creeks and meadows. Having learned these classifications, he would be able later to apply them in the classification of similar ideas which he might obtain through reading descriptions of places he has never seen.

The following illustration shows how the inductive method is used. You wish to teach your fourth grade class in geography the principle underlying the formation of dew. Does dew fall? Some may think it does, others may hold a different opinion. Let us experiment. Blow against the window pane. What happens? Moisture will probably be deposited on the glass. Where does this moisture come from? From the breath. Take a cup or a tumbler and fill it with hot water. Let the water remain until the tumbler is warm. Now blow against the tumbler. Does moisture gather on the outside of the tumbler? Why not? Bring a pitcher or other vessel, filled with ice water, into the room. Wipe the outer surface dry. After a few minutes examine this surface. What has happened? Where did this moisture come from? The pupils will soon see that the air is the only source from which it could come. Had the pitcher been filled with warm water, would the moisture have gathered on it? Through experiments of this sort lead the pupils to see that whenever air comes in contact with objects whose temperature is lower than that of the air, some of the water vapor which the air holds is condensed, or "moisture gathers on the cool surface." The fundamental principle is now understood. Lead the class to apply the principle to the study of dew, and they will of themselves solve the problem of its formation.

8. Merits of the Inductive Method. There are very decided merits in this method of instruction, among which the following are the most important:

(1) Knowledge gained in this manner is thorough, exact and lasting. It is the convincing, the stable, the certain method.

(2) The pupil who reasons by induction is confident in his conclusions, self-reliant in his thinking.

(3) The inductive method trains one to observe closely and to draw conclusions with care.

9. Limitations of the Inductive Method. A moment's thought shows us that there are certain obvious limitations to the inductive method, particularly to its use in the middle and upper forms of elementary instruction. The chief disadvantages are the following:

(1) Some studies by their very nature make their pursuit by inductive methods impractical. Algebra, geometry. history, parts of arithmetic dealing with abstract ideas, cannot be presented inductively.

(2) Induction is a slow process and requires much time. In crowded graded schools and in the rural schools the teacher is unable to present all subjects in this manner.

(3) Inductive methods require practical knowledge, skill and careful preparation from the teacher. This fact combined with (1) and (2) make it practically impossible to present all of any subjects in the intermediate and grammar grades inductively. However, it will remain absolutely necessary, if clearness of thought is to be preserved and real knowledge acquired, to introduce new subjects and to give aid in the exposition of difficult ones by the inductive method.

10. The Deductive Method. The inductive method has for its purpose the discovery of principles and the formation of definitions and rules. It begins with the individual idea or notion and leads to the formation of a general idea or notion. The deductive method begins with definitions, processes and rules and proceeds to apply them to individual notions. To illustrate: A boy has caught a bat. Is the bat a bird? In order to answer the question he must bring into consciousness all the qualities which constitute his general notion, bird. These qualities he applies to the bat and discovers that the bat possesses but few characteristics applicable to his general notion, bird. He therefore decides that the bat is not a bird.

A boy by experiment and constructions has discovered the rule, "The square on the hypotenuse of a right triangle is equal to the sum of the squares on the other two sides." He has a board and a foot rule, and wishes to ascertain whether or not the corners of the board are "square." He proceeds to apply the rule he discovered by the inductive method. In other words, he uses his knowledge. He measures eight inches on the side of the board and six inches on the end. Laying the rule on the board so as to connect these points, he forms a triangle whose hypotenuse will be ten inches, if the corner is a right angle.

The illustrations of the deductive method are innumerable. It may well be called the method of applying knowledge. When we teach by the deductive method we are in most cases asking our pupils to accept the reasoning of some one else, to profit by what others have learned. This is quite possible when the pupil is old enough to have some power of reasoning and is intelligent enough to assimilate ideas that come in other ways than by observation. Manifestly, then, the deductive method increases in importance as the boy and girl grow toward maturity.

For centuries the deductive method, the method of authority, was followed blindly by teachers, and until comparatively recent times the text-books were all built upon that plan. In some subjects, namely, algebra, geometry, grammar and those of like nature, the plan is still followed in many good books. You recognize them by the fact that they begin with the large general definitions, divide and subdivide the subject logically, and eventually arrive at the individual notions, which may be matters of common knowledge or intimately related to such matters. The processes involved are synthetic rather than analytic, and subjective rather than objective.

11. The Combined Method. That there are insuperable objections to the exclusive use of either of the methods we have discussed has become evident. We have found, too, that the inductive method is the basis of all real knowledge, and that, however we may slight it, the human mind normally reverts to it when in difficulty. We see that the teacher in the middle and upper grades of the public schools is in the midst of the transition period when pupils are gaining more and more power in deduction and require less and less of observation to enable them to "pass" in their studies. However, we must realize that practically every act of reasoning includes both induction and deduction. We form our conclusions by observation and comparison, then apply them to the problem in hand. Occasional objective teaching will always be necessary, and some subjects have little value outside the training they give in induction. Again, induction completes itself only in deduction; and thus we see that the true method of teaching combines the use of the two in such ways as best subserve the purposes for which the study is pursued and best assist in the development of the pupil who studies.

Teachers in the seventh and eighth grades occasionally ignore the inductive method as being something pertaining only to the primary grades; but the method of observation should be employed whenever it becomes necessary to a clear understanding of the subject under discussion. This is particularly true in teaching such subjects as arithmetic and geography. In arithmetic all the measures in common use, and models of those plane figures and solids upon which problems in mensuration are based, should be at hand so that the pupils by actual use of these objects may verify the principles and rules used in the solution of the problems. The work should not stop here. The pupils must be led to form mental images of these forms and to hold clearly in mind the principles they have discovered.

A globe is a necessity in teaching the form of the earth and the elementary facts of mathematical geography, but unless the pupils are able to apply these facts understandingly to the earth, they have learned but little that will be of use to them. The laboratory method employed in high schools and colleges is the inductive method, but it is not allowed to stop with the experiments performed. From these the student is expected to formulate principles and laws which he can apply deductively in the affairs in daily life.

12. Valuable Books. The earnest teacher who has time and inclination to go more deeply into the subjects treated in this lesson will find the following books of great assistance:

The Theory of Teaching and Elementary Psychology. Salisbury. 235 pages. Row, Peterson and Company, Chicago. A clear and practical exposition. One of the best books for the beginner.

Psychology and Psychic Culture. Halleck. 363 pages. American Book Company. A readable book that will serve as an inspiration to teachers of some training.

INDUCTION AND DEDUCTION

Induction and deduction can be illustrated by a socialized study by the class of Captain Eads' plan of building the jetties to deepen the passage through the mud-bar at the mouth of the Mississippi (the South Pass).

Let the children from assigned references find out and report to the class Captain Eads' method of constructing the jetties by building willow mattresses, how these mattresses were sunk along the sides of the pass so as to form new banks, narrowing the current. Then by forcing more water from above into this passageway, he developed a strong current which scoured out a deeper channel across the bar. The setting of a row of piles along the pass on each side to which the willow mattresses were tied gave permanence and solidity to the jetties.

The children, having worked out this plan in detail as illustrated by Captain Eads' successful building of the jetties, are able to demonstrate this method of building jetties and of deepening the passageway. They can then apply this same idea (deduction) to a similar construction of jetties afterward carried out by the government at the Southwest Pass (Mississippi) on a still larger scale.

Later the children may learn that at the mouth of the St. Johns River in Florida rock jetties were built parallel across the sand-bar formed by the sea at the mouth of this river. The sand between these parallel rock jetties was dredged out and pumped out so as to secure a deep passage for ocean-going vessels.

By comparing these two somewhat different methods of building jetties and of securing a deep passageway for ships, a conclusion can be drawn (induction) by which a broader statement is reached covering two cases. A later study of the jetty construction at the mouth of the Columbia River, rendered more difficult by the fogs and heavy storms along that coast, will include this somewhat different construction under the broader principle. A comparison of these cases with the deepening of the harbor entrance of New York (just outside the Narrows) will bring out a third method of dredging and marking a deep passageway for ships. As this last plan is compared with previous plans a still broader inductive conclusion is reached covering the entire series of cases.

This notion is then applied deductively to new cases as they may arise; the comparisons that follow lead to still broader inductions.

It is evident from the examination of this process of reasoning that deduction and induction follow each other in natural order and succession, each playing into and supplementing the other. Each induction becomes a basis for a later deduction, and deduction leads on to a comparison and larger induction.

What is commonly spoken of as the inductive method of working from particular instances by comparison to a general conclusion is in reality an inductive-deductive process in which induction and deduction follow each other in regular succession.

The failure, or mistake, often made in teaching is due to the unwillingness to introduce concrete instances as a basis for deduction as well as induction. It is the short-cut method of attempting to draw conclusions without any adequate basis in concrete experience.

This method of inductive-deductive reasoning applies with modifications to all studies in which general principles are to be demonstrated and applied. This double method would apply, for example, to the following topics:

The method of securing a water supply for cities.

The reclamation of swamp lands in different localities.

The development of inventions, like the steam engine, the sewing machine, in their various forms.

The study of biographies, like that of William Penn, in comparison with other religious leaders.

The study of oak trees compared with other hardwood trees.

The strategy of great battles, like Gettysburg and Chickamauga and others.

The government of the United States compared with other governments.

CHAPTER THIRTEEN

DRAWING

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INTRODUCTION

The value of drawing as an educational agency is simply incalculable. It is the first step in manual training. It brings the eye and the mind into relations of the closest intimacy, and makes the hand the organ of both. It trains and develops the sense of form and proportion, renders the eye accurate in observation and the hand cunning in execution.

—Chas. H. Ham.

The value of the work, however, should not be measured by the acquisition of knowledge or the power to express it, but rather by the love and the sympathetic interest awakened in nature and the profound reverence for the design and the protecting care revealed in the works of earth and sky by an allwise Creator. —Anna E. McGovern.

The sunshine drops, like a leaf of gold,
From the book of light above;
And the lily's missal is written full
Of the words of a Father's love.

— Phoebe Cary.

1. Aim of the Course. The child who leaves school without some knowledge of art and instruction in drawing, is not only sent forth without having acquired a valuable means of expression, but also without that language of art necessary to his interpretation of the works of the great masters, and to the comprehension of much of the beauty in the world about him.

Drawing is both a practical and a cultural study and, as such, it should be generally taught in the public schools. Much of the opposition to the courses in art is raised by those who do not know the scope and worth of the subject. These opponents regard drawing as mere picture-making which will be of no permanent benefit to the child. Showing the practical value of the subject through work done by the pupils, is the best way to overcome this opposition, and the chapters on Drawing in *Public School Methods* are designed to aid the teacher to present the subject in such a manner as to make it practical and helpful.

It is hoped, through a course in public school art, ultimately to improve the environment of the school and home, and eventually to bring about a greater interest in civic beauty, thereby increasing the pleasure of living, both for the pupils and their parents.

2. Arrangement of Plan. The plan here given is by months, covering the work for the intermediate and grammar grades, from fourth to eighth, inclusive.

If the course is being used in an ungraded school, type lessons may be chosen which will carry out the spirit of the plan. A general outline of the subjects treated during the year is given under the heading *Plan of Work*, and the teacher should refer to that section.

3. Materials; Use and Care. The work, to be carried out most effectively, is dependent upon the selection and proper use of both nature and art materials. The nature materials will be considered under the section entitled *Nature Study and Expression.*

The art materials consist of paper, pencils, crayons, outfit for water color work, rulers and paste.

(a) PAPER. The paper used for work in drawing and painting is an inexpensive manila, cut any size, but usually sold in two sizes, 6 x 9 and 9 x 12 inches.

Cream-tinted paper is preferred to white paper for work in water color, as the white dries too rapidly and because the white tone is too cold to obtain good color effects. The white paper is the best for pencil work, but the inexpensive, cream-tinted paper may be used very effectively for both pencil and color.

Colored paper for mounting and construction work, in neutral tones of brown, green and gray, lends an additional interest to the work; but an inexpensive substitute may be had in bogus paper, of heavier weight than manila, and of a warm gray tone.

Rice paper, a thin, transparent paper for use in copying work, is a delightful medium, but it is, in a way, a luxury rather than a necessity.

Squared paper, a manila paper with lines printed to form half-inch or quarter-inch squares, is used in design work; but pupils can draw lines with a ruler and thereby save this expense.

Mounting cards, covered with gray bogus paper, of good weight for use in mounting exhibits of work, should be included in a list of supplies.

(b) PENCILS. A soft pencil is necessary for use in freehand drawing; SS grade is a very good one. Any of the standard pencil manufacturers make good pencils for use in drawing—Dixon, Eagle or Prang.

Care of Pencils. The pencil should be sharpened to a blunt point and rubbed down on paper to make the best point for drawing. The drawing pencil should not be used for writing, but kept in cases made for the purpose, or by the children at their seats, in cases made for all their art materials. If pencils are kept by the teacher, each pencil should be marked with the owner's name, and should always be used exclusively by the owner, for sanitary reasons.

(c) CRAYONS. Colored crayons have become almost as universal a medium as the pencil, and, in the absence of water color, are a substitute for that medium. If but one medium can be obtained, a box of colored crayons is recommended as the best medium to purchase. A box containing eight colors—red, orange, yellow, green, blue, violet, brown and black—is manufactured by several reliable firms, whose addresses are given under the heading *Supply Houses*.

(d) WATER COLORS. The use of color in connection with art study is indispensable. Surrounded by a world of beauty in color, one can only inadequately express form without the use of color. The three-color box, containing red, yellow and blue, with black added, is the most acceptable for school use. The colors may be purchased separately at three cents per cake.

(e) BRUSHES. A No. 3 sable brush, costing seven cents, has been found the most practical for general use in school work. A Japanese brush for line work is very convenient and inexpensive, but the sable can be substituted.

(f) WATER COLOR PAN. This may be purchased at slight expense. It is a small, black, japanned tin, with enamel lining. Tops of tin cans or fruit jars may be made to serve as substitutes.

(g) GENERAL CARE OF MATERIALS. Most of the materials needed in art lessons can be cared for by the individual pupil by placing in his desk, in a box or cloth case made especially for the purpose, everything belonging to one child. Materials furnished by the school, such as paper, should be passed out at each recitation.

4. Supplies and Supply Houses. The art materials enumerated, as well as many others, including drawing textbooks for pupils' use, and teachers' manuals, may be obtained at the following supply houses:

The Prang Co., 6 N. Michigan Ave., Chicago; D. C. Heath & Co., 1815 Prairie Ave., Chicago; Scott, Foresman & Co., 633 S. Wabash Ave., Chicago; Atkinson-Mentzer Co., 2210 S. Park Ave., Chicago; Joseph Dixon Crucible Co., 53 W. Jackson Boulevard, Chicago; Milton Bradley & Co., Springfield, Mass.; Devoe & Raynolds Co., 14 W. Lake St., Chicago; and the Thomas Charles Co., 207 N. Michigan Ave., Chicago.

It is suggested that teachers send to these firms for catalogues of materials and price lists.

PLAN OF WORK

5. Introductory. The work is so planned that the portion for each month is arranged and explained in detail under its proper heading. The work can be adapted to the needs of either intermediate or grammar grades by selecting simpler or more complex subjects, and this selection will depend quite largely upon their previous training. In schools where drawing has not previously been taught, the teacher will need to begin with simple subjects in all grades.

In order that each teacher may understand clearly all the principles explained in these lessons, it is absolutely necessary that she perform, herself, all the work indicated. She should work out with great care each direction given, for if she does not understand each step to be taken in making a drawing, she will be unable to give the clear, specific directions to children which will enable them to make correct drawings. After completing each lesson, practice drawing many simple objects based upon the principles discussed in the text. If the first results are not satisfactory, do not be discouraged. The old adage that "practice makes perfect" is doubly true in drawing. Practice persistently, and, after completing a drawing, examine it to see wherein it could be improved. Occasionally compare the work with an illustration of some similar study given in the text. Then try again. By working this way, one will surely succeed.

After completing the lesson for each month, prepare the work required in the *Test*, as an evidence of your progress. The drawings should all be made on regular drawing paper.

6. September. The work for September includes the study of various nature materials—grasses, weeds and flowers—in different mediums. If the work is being adapted to the needs of the intermediate grades, or to children in the grammar grades who have had little or no experience, care should be exercised in choosing the simpler subjects, such as the common foxtail, timothy, millet or cat-tail, in the grass family; among the weeds, the milkweed, jimson weed, etc., would make large, simple subjects, while among the flowers the brown-eyed Susan, cosmos, sunflower and other single flowers would be the ones to select.

The more complex forms—oats, wheat and rye, among the grains, and the thistle and field flowers—could be chosen for the grammar grades.

7. October. In October the various grades might be assigned the study of a few trees for special consideration, again choosing the simpler ones for lower grades, as maple, poplar, elm, oak, apple, evergreen, beech, sycamore, birch, locust, in the order named.

The October landscape may be made as simple or as complex as the ability of pupils suggests. The range may extend from flat washes, to represent sky, ground and distant trees, to a special study of clouds and fields, and trees in the foreground with their wealth of color.

8. November. The work in November includes the study of seed pods, vegetables and landscapes, which may be adapted to the ability of any grade. Choose the larger forms in seed caskets and vegetables, and a single bare tree in the landscape, for the younger pupils; more complex forms, such as a branch of oak, with acorns and a chestnut burr, may be assigned the older pupils. The study of the November landscape may include a group of trees, or trees and a house, with a road or path in perspective. Use the landscape, with some appropriate nature quotation, in the upper grades. The text appropriate for Thanksgiving is a good upper grade problem, while the "Mayflower" would be simple enough for the intermediate grades.

9. December. The construction work in December should be planned with reference to the ability of the children. Box making, with simple decorations, would be a good problem for fourth and fifth grades, while basket making would be better adapted to the grammar grades.

If the school is ungraded, the teacher may give box making to all grades, varying the problem by allowing the upper grades to make the larger box, where the decoration becomes a more important feature.

The exercises on Christmas cards, or texts, may be made simple or elaborate, as the teacher plans.

10. January. If the pupils are familiar with the principles of cylindrical perspective, they can carry their work in object drawing to more difficult objects, which have handles, spouts, etc. The studies may include the grouping of several objects, or a still life object and some fruit or vegetables grouped together.

The effects of dark and light may be expressed in pencil painting, in upper grades, while the crayon work will be better adapted to the lower grades.

11. February. The work in rectangular perspective, in February, may be made simple enough if it is introduced by giving observation lessons, having the pupils express what they see, without too much discussion of principles. Use single boxes and books in the lower grades; the group of objects can be used for more complex problems for the upper grades.

12. March. The outline for March provides for the continuation of object drawing for grades sufficiently advanced in the work to make it interesting, and at this point the study of the figure is introduced. Animal and nature work may be continued for the whole month.

13. April. The nature subjects in April will include plants, birds and insects, chosen with due regard to the ability of the children to express them, and also with regard to the choice of the medium used in expression. Colored crayons, for instance, are an easier medium to use than water colors, and the study of the form only, expressed in outline with the pencil, is the simplest of all.

14. May. Nature studies are to be continued. Landscapes in simple wash effects may be introduced into the intermediate grades, and the higher grades can adapt the landscape or flower forms to decorative purposes, illustrating nature booklets and other articles to which the designs can be appropriately applied.

15. June. The closing work of the year should include a further application of the problems of decoration from nature motifs, and from the various suggestions given throughout the year. Suitable problems may be chosen to meet the needs of any of the several grades, by allowing the lower grades to use the simplest nature subjects in their designs.

16. Summary.[1] The work of the year is planned to use the interesting material of each season, and the teacher should at all times look for the many opportunities to correlate the drawing with all the other school subjects. Drawing should become an illuminating means of making all other thought more easily comprehended, appealing to the sense of sight, through which much of our knowledge comes.

NATURE STUDY AND EXPRESSION

17. An Appreciation of Nature. Do you know the best way to interest children in nature and to create a love for representing nature's forms? Have you ever tried the plan of going on a nature tramp with the children, and enjoying with them the beauties of nature? The trophies you will find on such a walk will serve as interesting material for both nature and art study for several lessons. The different varieties of grasses, including the grains, the wild flowers, the pretty weeds, including the thistle, jimson weed, teasel, curly dock and others; the trees, the panorama of sky and ground, and the insect world are all marvelously interesting when we become intimately acquainted with them

SEPTEMBER[2]

September waves her golden-rod
Along the lanes and hollows,
And saunters down the sunny fields
A-playing with the swallows.

18. First Week. (a) ARRANGING FLOWERS IN VASES. The nature material which you have gathered will serve admirably to decorate the schoolroom, and will, at the same time, afford a valuable lesson in flower arrangement. Ask the children to bring from home some common crocks, fruit jars, and large-necked bottles to use as vases, and then assist the children in choosing the nature material most suitable for the different receptacles, or ask the children to assist you. Do not arrange a great variety together; this gives a confused mass of forms and colors. If the flowers are large, like the sunflowers, golden glow, or field lilies, arrange those of only one kind together. Do not strip the leaves from them, but arrange them to give the most natural effect possible. Sometimes two kinds of flowers may be massed together so as to give a most pleasing effect, through contrast of form or color. The golden-rod with white or purple asters would be effective, or field lilies with white asters; but the golden-rod with the field lilies would not form a desirable group, because the color combination would not be so pleasing.

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[1] The work as outlined in Sections 6-15 is the regular course given to the students in the Western State Normal School, Kalamazoo, Michigan, and most of the illustrations in this chapter have been made by students in regular class work. The course in general has also been given to the children in the Training School.

[2] Consult Section 6, page 371.

We may profit by the advice of John Ruskin, the eminent English art critic, who said, "Let us have nothing in our homes which we do not know to be useful, or believe to be beautiful." This will apply equally well to our school home.

After the children have beautified the schoolroom with these large and showy bouquets, it will stimulate their love for the beautiful to allow them to have on their desks a bottle containing grasses or a pretty flower. This will also do much toward cultivating an appreciation of beauty in nature.

(b) FLOWER ARRANGEMENT ON DESKS. Procure small sprays of flowers or pretty grasses. Provide each pupil with a sheet of drawing paper 6 x 9 inches in size.

Have the pupils arrange their flowers or grasses on the paper so that they will make a pretty study for use in drawing. Place one spray so it will look well (natural) in the space. Try placing it centrally, but not stiffly in the exact center. Do not place it slanting from corner to corner. If the stem grows erect, show the direction by placing it in this position. Then try placing two sprays together. Is greater beauty obtained by placing one a little higher in the space than the other? Make the sprays look as if they were good friends; do not have them cross each other. In this way variety and unity, two essentials in a good work of art, may be obtained. After two sprays have been satisfactorily arranged, try placing three together. Arrange them to suggest the way nature arranged them while growing. Allow some of the children to show the arrangement they have made by drawing lines to represent the stems in an oblong space on the blackboard. Others may draw on a piece of drawing paper at their desks.

During the progress of this work, notice what difficulties the children have in handling their materials. Observe also the position of body, hands, arms and limbs while drawing. It is very essential that good habits of work be established at the beginning; therefore, a drill lesson should precede any definite work in drawing.

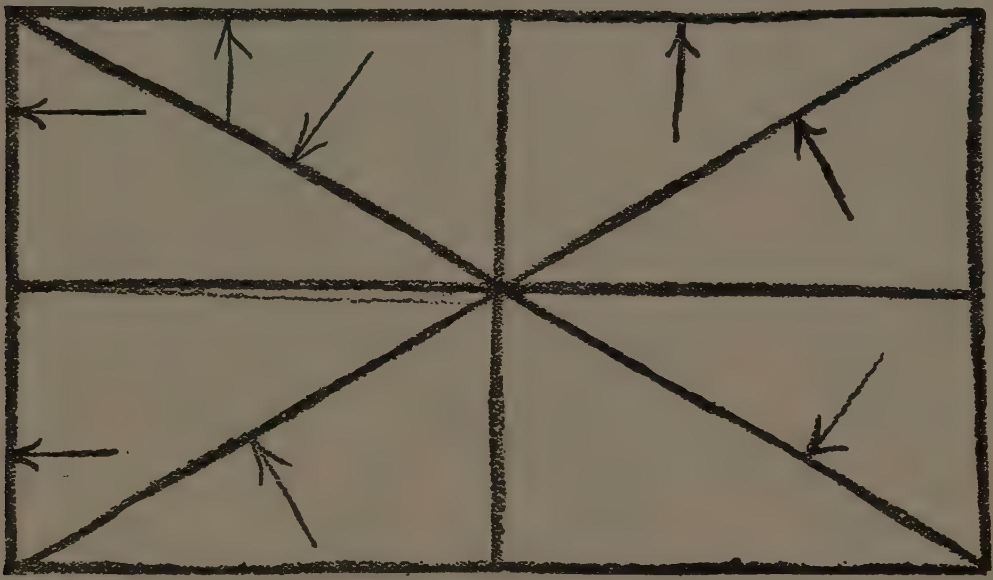
(c) LESSON ON PROPER POSITION. Supply each pupil with manila paper 6 x 9 inches, and a drawing pencil.

Previous to the lesson the pencils should have been sharpened, exposing a piece of lead between $\frac{1}{8}$ and $\frac{3}{16}$ of an inch in length. Do not use a pencil sharpener. A knife should be used to cut away the wood, and the lead should then be rubbed on a piece of manila paper or emery paper, making a rounded point. The lead should be so shaped that it will make a broad, soft line.

(1) *Holding the Pencil.* Take the pencil lightly between the thumb and first and second fingers, grasping it at about the center. The pencil should be held at right angles to the line to be drawn, as shown in the illustration. The arrow lines show the position of the pencil, and the heavy lines show those to be drawn. Move the pencil lightly across the paper from left to right. In drawing a horizontal line, the pencil should make a smaller angle with the paper than for other lines. Count for movement, "Over, back; over, back; over, ready, draw." See that the pupils follow directions. For vertical and oblique lines, the directions may be, "Down,

back; down, back; down, ready, draw." Do not change the direction of the pencil while making the movement.

(2) *Exercises.* Draw a page of horizontal lines about one inch apart, then draw vertical lines, making squares.



POSITION OF PENCIL

Turn the paper over and make oblique lines from corner to corner, and lines parallel to them, one inch apart.

In all exercises, see that the pencil is held in a position that makes a right angle with the line drawn. The line should be a broad, soft gray line of uniform width. (See illustration.)

In every lesson allow some children to draw at the board. The crayon should be short, from 1 to 1½ inches in length, and should be held between the thumb and first and second fingers, with the broad side to the board. The pupils should stand as far away from the board as possible, and work at arm's length. The position of the crayon should be the same as that of the pencil—at right angles to the line drawn.

(d) DEFINITIONS. Write all new terms on the board, and define them: horizontal, vertical, oblique, oblong, diameter, diagonal.

A *horizontal* line is a level line.

CAT-TAILS

A *vertical* line is an upright line.

An *oblique* line is a slanting line.

An *oblong* is a four-sided figure, longer than it is wide, and having its opposite sides equal and parallel.

A *diameter* is the length of a straight line through the center of an object, from side to side.

A *diagonal* is a line drawn from two corners not adjacent, and passing through the center of the object.

19. Second Week. GRASSES. Supply the pupils with pencils and paper 6 x 9.

If you have enough grasses, put a few on each child's desk, and ask each one to make a pleasing arrangement, as in the previous lesson. There are numerous grasses that may serve well for this lesson, as the common foxtail, that grows on every roadside; millet, wheat, rye and barley also make interesting studies.

Direct the children to draw marginal lines on the paper which they have, making a good framing space for the picture. At the beginning of the exercise review the position at the desk, and manner of holding the pencil. Have the pupils sketch lightly to show the position of the stems in the space allowed for the picture, and then after studying the structure of a head of grass, have them try to show its appearance in their drawing.

Vary the work during the week by having different varieties of grasses. Use the grains, if possible. Cat-tails make a strong, simple subject. These may be fastened to a cardboard at the front of the room, where all the children can see them, or they may be left in a jar on the teacher's desk. Allow the children to make their own arrangement on the paper.

Colored crayons are a good medium to use in this study. Select the brown and green crayons that match the head and leaves, and use them as you do pencils. The long, slender heads and stems will suggest a long, panel-shaped paper, and the pupils should fold a 9 x 12 sheet so as to make a narrow panel.

If colored crayons cannot be provided, the pencil shading may show dark for the color of the brown head, and lighter strokes for stem and leaves. Make the strokes lengthwise through the leaves, to suggest the parallel-veined growth. The heads may be shown with slanting, or vertical strokes. Notice the difference in the light and shade side of the brown heads. Half close your eyes to simplify this effect. Arrange to have the light fall on the study from one side only. If there are cross lights, draw the shades at one side or back of the room. Have each pupil hold the study he has drawn as far away from him as possible, and compare the drawing with the subject, with half-closed eyes, and judge the general effect. If any of the studies are lighter than the subject, the pupil should go over the lines again, making them a little darker. See illustrations of grasses in pencil.

STUDY IN GRASSES

20. Third Week.

(a) WATER COLORS. Each pupil should have manila paper, a paint box, a brush, a small dish of water, and a soft cloth. Place the painting materials at the upper right corner of the desk. Open the paint box, placing the cover toward you, for use as a palette. If the children have not used water colors before, ask them to look at and name the colors—red, yellow, blue, and possibly black. These three first-named colors are called *primary* colors, because from them other colors may be produced. Ask the children to experiment and see what colors they can make. Give the following directions:

(1) With your brush full of water, put a few drops on each cake of color to soften it.

(2) Put a few brushfuls of water in one of the little divisions in the cover.

(3) Make a green wash. First rub the brush lightly across the yellow cake, and mix the yellow in the water. Now add some blue, and watch the transformation; it produces green; adding more blue makes a darker, or bluer green. To lighten the color, add more water; more yellow added makes a yellow-green.

(4) Try on your paper the green wash you have made.[1] Fill the brush with the green wash. Commence at the top of the paper and sweep across the top from left to right. Then continue filling the brush, and with short, vertical strokes from left to right, cover the surface as rapidly as possible, insuring, by so doing, a smooth surface.

If a graded wash is desired, add a little more water to the wash, making it lighter as it comes to the bottom of the paper. Make about two green backgrounds, adding a touch of red in the second one, which will make a gray-green color, and make a graded wash. Allow these to dry and save them for the next lesson where a tinted background is needed.

(b) WEEDS OR GRASSES. Tinted backgrounds and some pretty colored weeds, or grasses, that you have in your nature bouquets, form the materials for these studies.

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[1] Be sure to use manila paper for all work in water color, instead of white drawing paper, which gives a cold background and dries too rapidly, due to the amount of lime used in bleaching it.

Have you noticed that some of the weeds and grasses are already turning to brown or red autumnal colors? The curly dock or pigweed will make a pretty study. The studies may be fastened on pasteboard easels, made by folding a long piece of cardboard and resting it like an easel. Place these on boards between the front desks. Pin the studies against some of the tinted backgrounds to study the effects. If the children do not have water colors, use the crayons to make a tinted background.

STUDY IN GRASSES

Use the color that matches the color of the weeds, making a light tone for the background. Draw the stem lines first, and notice any peculiarity of growth of the seed heads. Try to show the exact formation of the stem and fruit.

(c) Flower Painting. Any large single flower will be suitable for this exercise. Small sunflowers, the brown-eyed Susan, or the field lily are suggested. Express the study in water colors on manila paper.

Before trying to express the beauty of the flower in water color, give a short lesson on handling the brush and color. Let the pupils try making the green you see in the leaves, mixing the colors in the brush by taking first a little yellow, then a little blue and a touch of red, to make the green less vivid. Each pupil should try the color he has made in his box top or palette. If the color is too dark, he should take another brushful of water, or touch the yellow cake, to make it more yellow. Now have the pupils touch their brushes to the paper to see if the color matches the leaves. The next step is painting the stems. The pupils should hold the brush in an upright position, and with the point make some firm, slender strokes to suggest stems. Then they should try pressing down on the brush gradually, to widen the stroke, making the stem wider. To make the leaves, fill the brush with color, hold it upright, and, commencing at the apex of the leaf, gradually press down on the brush, making a stroke as wide as the leaf. If this is not possible, make another stroke beside the first one, and continue

STUDY IN GRASSES

the strokes until the width and shape of the leaf are obtained.

After practicing to obtain the shape of stems and leaves, clean the brush on the cloth (not in the water), and mix the color for the flower. If the flower is orange color, use yellow and red together; if violet, use red and blue mixed. Experiment until the right color is obtained.

If the flower has separate petals, like the sunflower or the brown-eyed Susan, try making a petal with one stroke of the brush. Arrange the petals around the center, and notice that those projecting forward look fore-shortened; that is, shorter than those at the sides. Now paint the flower on another piece of paper. If your brush is full of the color of the flower, paint the flower first; or the stem may be painted in first, and leaves and flower added. Try to show the arrangement of the leaves on the stem. Are they alternate, opposite or in whorls? Also show the shape of the leaf, if it is turned, or foreshortened. If the leaves are slightly brownish, add more red to your yellow and blue.

Cautions. (1) Be sure to have the pupils clean their brushes on the cloth whenever they mix a new color for the flower.

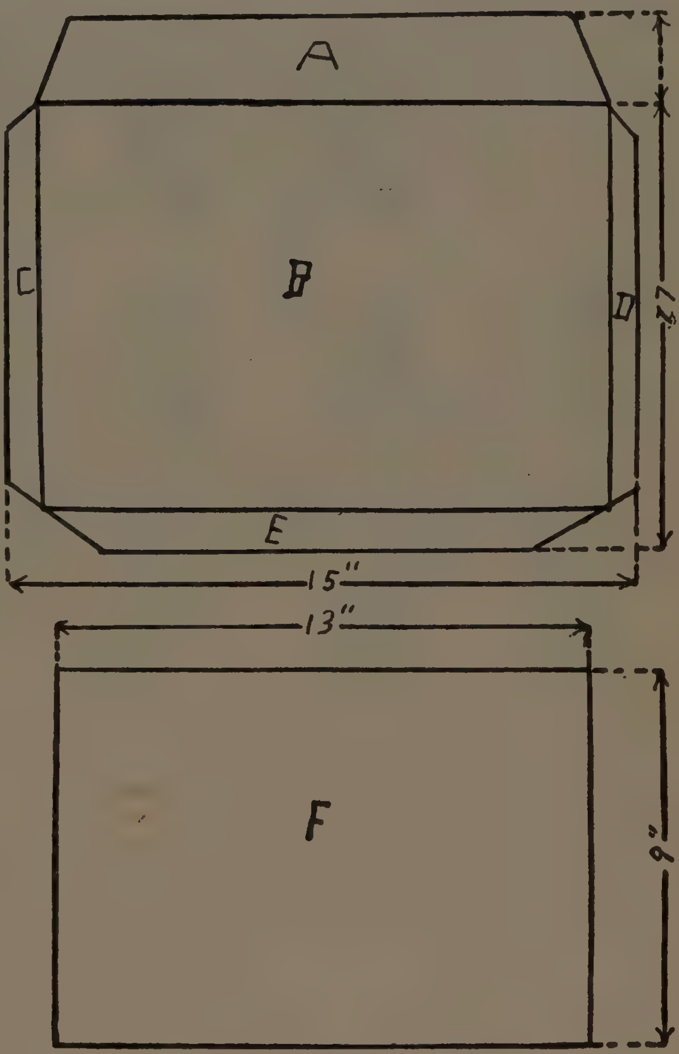
(2) Keep the water in the pans as clean as possible.

(3) Be careful not to mix mediums. Do all the work with water colors, not using a pencil to outline the forms first. Work directly in the flat mass effects with the brush and color. If pencil is used, try to show the contrast of color in the flower and leaves by pencil shading. See illustrations in pencil painting.

If the pupils have no water colors, colored crayon or pencil may be substituted, and the flower represented in either of these mediums.

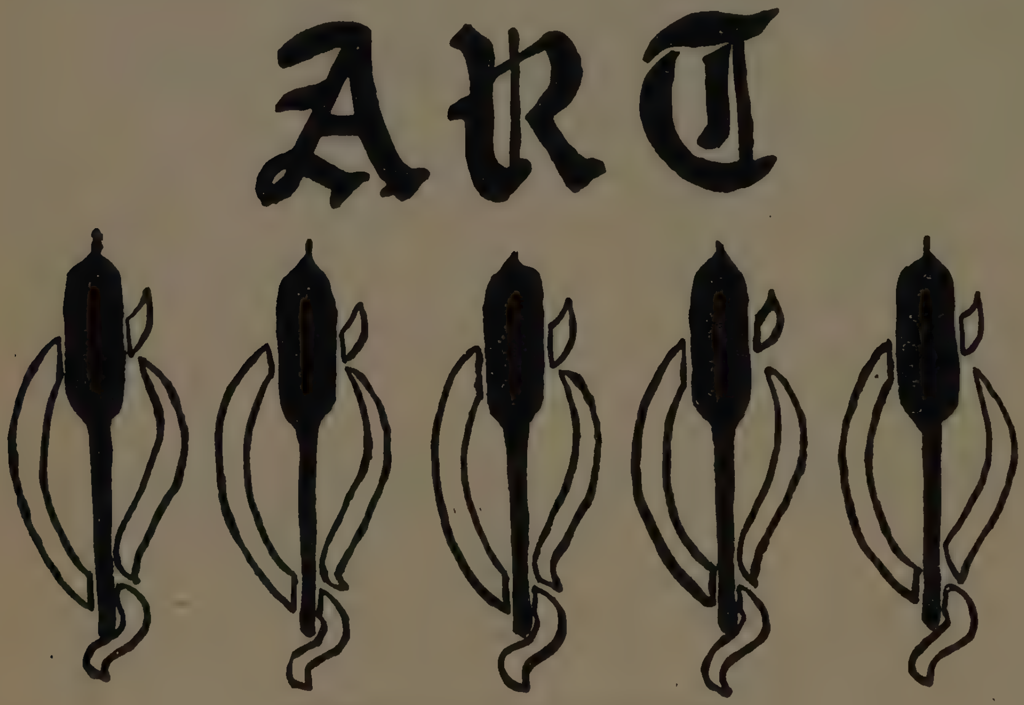
21. Fourth Week. (a) ENVELOPE FOR DRAWINGS. The children should make envelopes in which to place their drawings. Use bogus paper for this problem in construction, or, if this cannot be obtained, use any tough wrapping paper, such as is found at the butcher shops or grocery stores. When completed, the envelope should be 10 x 13 inches in size. This will allow sheets of 9 x 12 drawing paper to slip in and out easily. The full size of the sheet from which this may be cut should be 14 x 23 inches, or it may be made from two smaller pieces, one being 9 x 13, the other 14 x 15 inches. The larger piece allows for one-inch laps on three sides, and a three-inch lap on one side. Fold the larger piece (C, D and E) down to B; apply the paste to these laps, and paste the left, right and lower edges of F down on B. Fold the flap A after the envelope is pasted, and put under a weight to dry.

The envelopes may be decorated with some nature unit that the pupils have studied during the month. Some simple flower or leaf motif, or the cat-tail, will serve well for this purpose. If a flower form is chosen, select some simple flower, like the brown-eyed Susan, and with free brush strokes paint the center and the petals arranged around it. Work by opposites in representing the petals, placing one at the top, then one at the bottom, then at the left and the right sides, and filling in as many between as there is room for.



DRAWING FOR ENVELOPE

This design may be carried out in water colors, or colored crayons. The units may be arranged in a border at the bottom of the envelope, at the top and bottom, or on all four sides. (See illustration with cat-tail design.) Divide the space to be filled with the design into equal spaces, by drawing lightly with the pencil. Place the unit in the center of these spaces, thus making a border around the envelope. The child's name may be printed on the envelope with the same color as is used in the design. If there are no water colors, colored crayons or ink may be used. Be careful not to use strong, gaudy colors in the design. Do not use the primary colors (red, blue or yellow), but the secondary colors, green or violet, may be used; or, better, mix the primary colors together, making a brown.



DESIGN FOR ART ENVELOPE

(b) Tertiary Colors. Colors obtained by mixing all three colors are called *tertiary*. They are olive, citrine and russet. Citrine has more yellow than red and blue; olive has more blue than red and yellow; and russet has more red than blue and yellow.

(c) Mounting Drawings. Supply the pupils with 9 x 12 manila paper, scissors and paste.

Show the children how drawings and paintings can often be improved by cutting down the surplus background, putting a dark line at the edge of the study (paper), and mounting it on larger paper. If you have no scissors, the children may fold and crease their papers firmly and tear them, instead of cutting. If library paste is not at hand, make flour paste and use just a drop under each of the four corners of the study. Do not spread paste all over the back of the study.

(d) Exhibits. Make an exhibit of the best work done during the month. There is nothing which encourages children so much as to see their work on exhibition in comparison with that of others. Every schoolroom should have a bulletin board, or a space covered with burlap, where children's work may be exhibited. If nothing better can be devised, a piece of black mosquito netting can be hung and the drawings pinned on that. A more permanent exhibit may be made by pasting drawings on mounts of large gray cardboard. Mounts on tag-board may also be used. Do not paste too many drawings on each mount. Not more than three sheets of 9 x 12, or six sheets of 6 x 9 should be placed on a cardboard mount 22 x 28 inches. Fasten the mounts together, three deep, if arranged vertically, and four deep, if fastened horizontally, by tying them together with a twine or tape to match the cardboard. Punch holes with punch or nail, through which the cord is passed. These rows of mounts can be hung on the wall from the moulding.

(e) Illustrating Written Lessons. Some of the art work done during September may be used to illustrate nature compositions. Have the pupils write compositions on the subjects connected with your nature tramps, and illustrate them with their nature drawings and paintings. The composition and drawings may be fastened together, and enclosed within a cover of drawing paper, bogus paper or wrapping paper. Fasten the booklets together with paper fasteners, or tie them together at the back with a cord that matches the cover.

Test. Make two pencil drawings of grasses from nature. Make a design for an art envelope, using a nature form, but, in this instance, do not use cat-tails. Use ink or black water color.

OCTOBER

The world puts on its robes of glory now,
The very flowers are tinged with deeper dyes,
The waves are bluer, and the angels pitch
Their shining tents along the sunset skies.
—*Albert Leighton.*

22. Subjects for the Month. The beautiful month of October has long been a favorite theme for poet's pen and artist's brush. Whittier, Longfellow, Tennyson, Alfred Austin, Alice Cary, Helen Hunt Jackson, Lucy Larcom, and a host of others have voiced in song the beauties of October. The French artists Rousseau and Diaz, and in America George Inness and the Hoosier group of artists have immortalized on canvas her glorious color. There are such riches from which to choose in nature, literature and art, that one has but to open his eyes and behold them on all sides. There should be daily observations of nature, and the written exercises in various branches should be freely illustrated with brush, crayon and pencil, in order most completely to reveal the beauties of this queen of months.

Some of the interesting themes for study and enjoyment are An Autumn Walk, An October Landscape, Trees in October, Flowers of Autumn, Fall Fruits, A Nutting Party, Harvest Time, Mother Nature's Treasure Caskets. Consult Section 7, page 372.

23. First Week. (a) TREES. Use manila paper and water colors.

Choose one of the trees the pupils have studied on their walks. Ask them to compare the shape and color of the maple, the oak and the elm, and note the points of difference. Which is the tall, graceful tree; the strong, sturdy one,

PINE
EMG

OAK
EMG
WINTER

and the symmetrical one? What colors are in the foliage? Have the class paint the trees in their proper colors. Mix the color in the brush, and mass in the shape of the tree,

TREE STUDY

commencing in the center and working out to the edges, showing where the widest part is, also showing whether it is regular or irregular at the edges. After painting the foliage, the trunk should be added by mixing all three colors for the gray color of the trunk. If branches are visible here and there, add a touch of this color to represent them. If you have no water colors, use pencil or crayon to represent the tree.

(b) OCTOBER LANDSCAPE. Water colors and 6 x 9 manila paper are the best materials for this exercise.

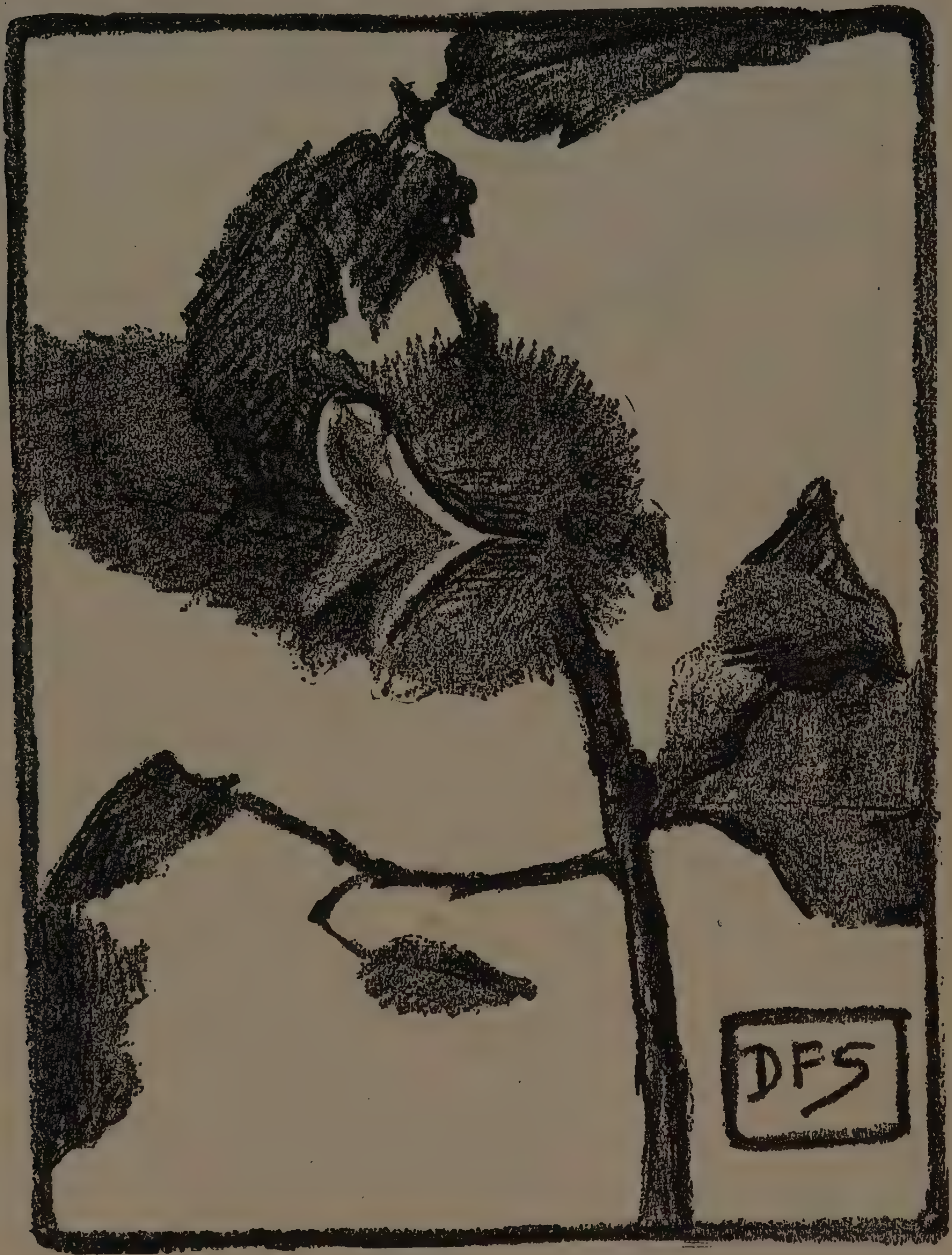
Study the color of the sky, the ground and the distant trees. Put a water wash over the surface of the paper. Represent October's bright blue weather in making the sky blue, bringing the color over the whole paper. What colors are seen in the fields now? Represent the ground space by mixing all three colors, to obtain the golden-brown or the gray-green. If the trees have changed color, try massing the color along the horizon to represent the distant trees.

Pencil work in landscape study may be used in place of color. If the pencil is used, represent the ground with pencil strokes drawn close together, to show the darker mass compared with the sky, and then the trees may be represented in a still darker mass, using slanting strokes.

24. Second Week. AUTUMN FLOWERS, VINES OR WEEDS. Use the same materials as were required in the last exercise.

If the flowers still remain, use a simple arrangement of asters or golden-rod, and try massing in the color to show the form of the mass of flowers, leaves and stem. When flowers grow small and in bunches, the color may be applied in mass. Do not try to show too much detail.

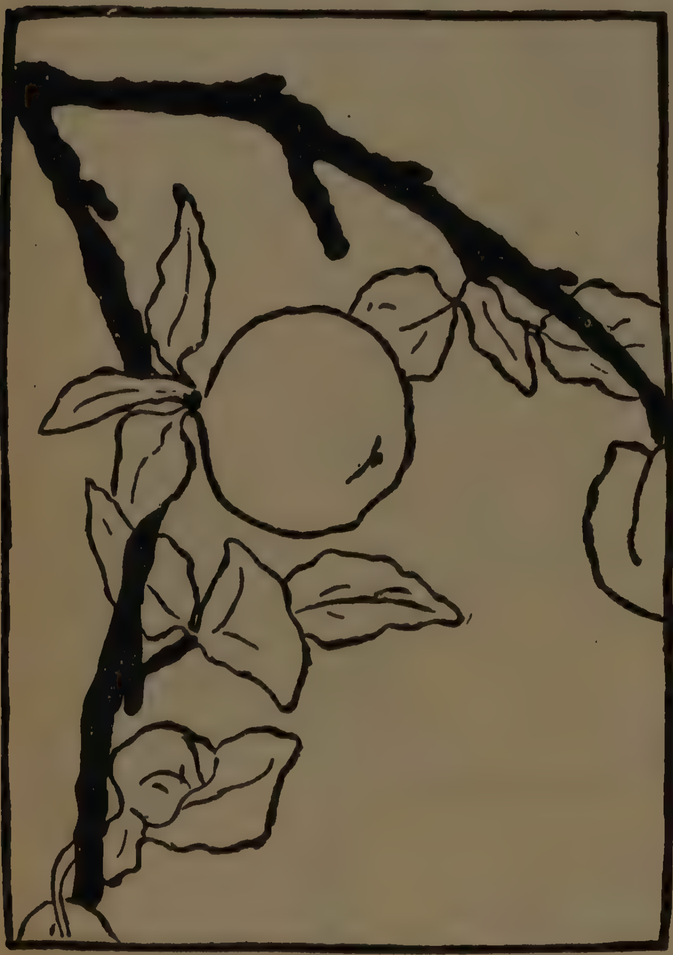
Water color is the most suitable medium for flowers, while the weeds may be shown nicely in colored crayons. See illustrations. Try making a study of the curly dock or the teasel burr with the brown crayons. You should arrange the studies so that all the children may see them. To give an idea of the proportionate size of the subject, it is well to fasten the studies upon paper of the same size as that which the pupils are using. If the pencil is used, try to show the shape of the parts, and then by shading show the value of the color. The *value* of the color is its degree of light or dark. If the color is light or dark, represent it by light or dark shading in pencil.



AN OPEN SEED VESSEL

25. Third Week. BRANCHES. Branches of fruit, as the apple or pear, a branch of oak with acorns, or a tomato vine with its fruit, are suitable subjects for study. Use 6 x 9 manila paper and pencil.

Draw an enclosed space, or margin, about one inch from the edge of the paper. Study the arrangement of leaves and fruit on the branch, and sketch the stem to represent its position and character. Sketch the leaves lightly so as to show the arrangement, but do not try to represent them all, if there are many. Show the shape and size and arrangement of the fruit. Make a good outline drawing in this first lesson.



BRANCH OF AN APPLE TREE

Continue the study of the branch with pencil painting or water colors. If water colors are used, paint a gray-green background first, and, after that is dry, represent the color of leaves, stem and fruit. A perfectly flat wash may be used to represent this study without showing the effect of light and shade, and the study can be finished by painting a strong black line at the outline of each part when the color is dry, thus making a decorative study of it. See illustration of apple on branch.

If there is time, a pencil painting may be made of the same study, even if color has been used. If the pencil is used, make a light outline first and then, with slanting

Plate One AN AUTUMN SCENE

strokes massed close together, show the depth, or value, of the color of the study.

26. Fourth Week. (a) OCTOBER LANDSCAPES WITH TREES. Use water colors and 6 x 9 paper.

In our previous landscape study we represented the trees in the distance as massed in, in simple silhouette effect. In this lesson we wish to show the tree in the foreground; consequently, it will appear much larger and in brighter color. Paint the sky and ground as directed in the previous lesson on landscape. While this paper is drying, paint the tree you wish to represent on a dry piece of paper, representing the bright red and yellow of the maple, or birch, the russet color of the oak, or the dark green of the apple or elm. Try painting the tree on the original paper before it is quite dry, as this gives a softer effect to the edges, which suggests the haze of the atmosphere over everything. This is very important. (See Color Plate One.)

OCTOBER LANDSCAPE

(b) ILLUSTRATING POEMS. Another lesson might be given by reading a descriptive poem to the children, and asking them to illustrate it with color. The water color is preferred for landscape work. Here is an appropriate quotation:

OCTOBER

THE MORNS ARE GAYER THAN THEY WERE,
THE NUTS ARE GETTING BROWN;
THE BERRY'S CHEEK IS PLUMPER,
THE ROSE IS OUT OF TOWN.
THE MAPLE WEARS A GAYER SCARF,
THE FIELD A SCARLET GOWN:
LEST I SHOULD BE OLDFASHIONED
I'LL PUT A TRINKET ON!

It was late in mild October,
And the long autumnal rain
Had left the summer harvest fields
All green with grass again;
The first sharp frosts had fallen,
Leaving all the woodlands gay,
Like the hues of summer's rainbow
Or the meadow flowers of May.
—*Whittier.*

Ask the children to close their eyes and try to see the picture in imagination; then let each child paint the picture as he sees it. The older pupils may grasp the picture from a single reading, but the younger ones should have an opportunity to study the stanza before attempting to illustrate it. See the illustration of October landscape, Color Plate One.

(c) AUTUMN LEAVES. A branch of oak or maple leaves makes a delightful study. Use them when the color is at its best. Try painting them in, without drawing, in what is called the free brush work. Do not have too many leaves on the branch—two or three will give a pleasing effect. See illustration with the poem on October, page 396.

(d) MOUNTING. Have a mounting lesson again to complete the month's work, and make an exhibit of the best work. See Section 21 (c), page 387.

Test. Make a drawing of a tree from nature. Use the pencil.

If you have water colors, paint a simple October landscape. If you have no colors, illustrate in pencil a simple poem.

Draw a fruit branch, in pencil.

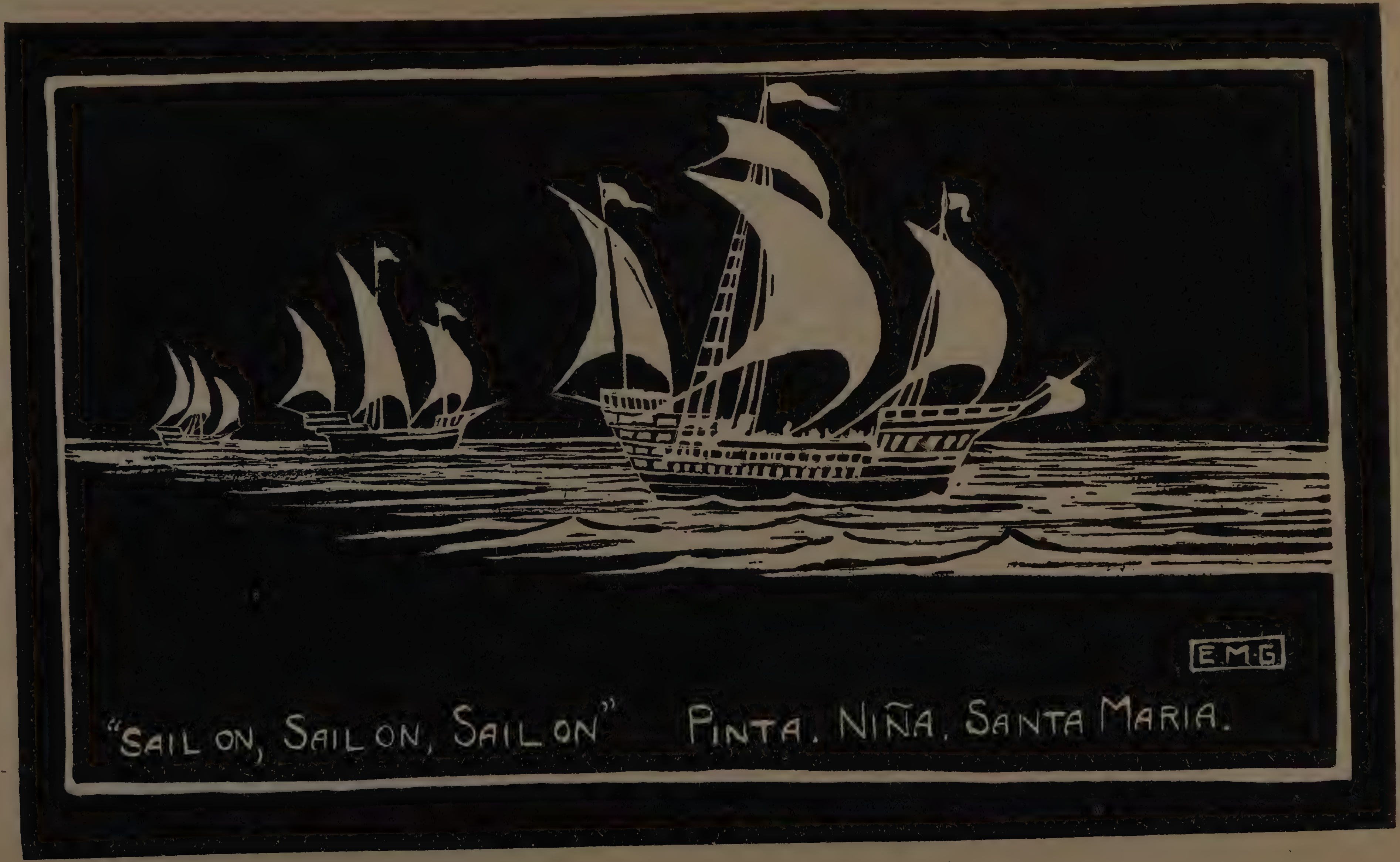
NOVEMBER

Pleasant summer over,
And all the summer flowers;
The red fire blazes,
The gay smoke towers;
Sing a song of seasons,
Something bright in all;
Flowers in the summer,
Fires in the fall.

NOVEMBER

DATE

SUN	MON	TUES	WED	THU	FRI	SAT
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30					

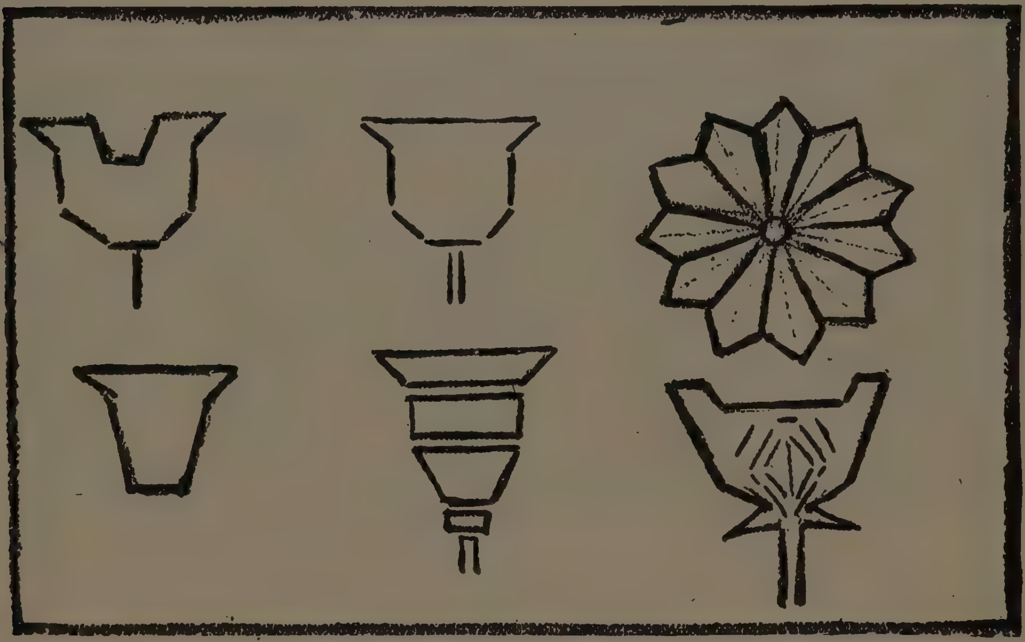

"SAIL ON, SAIL ON, SAIL ON" PINTA. NIÑA. SANTA MARIA.

27. Nature in November. In this month Nature presents a changed aspect from gayly-robed October, but November has beauties all its own. Notice that the trees that were so recently painted with gorgeous dyes are showing now their characteristic lines in trunks, limbs and branches. The underlying structure of the trees may now be more fully studied and enjoyed than before. Can you tell the different trees when the leaves are gone? How many of your pupils can tell them? Choose a half dozen trees, and make a special study of them with the class. The sturdy oak, the graceful elm, the knotted apple tree, the symmetrical maple, the delicate birch, are as beautiful to the appreciative eyes of the nature lover, when the bare branches form delicate traceries against the sky, as when clothed with nature's most gorgeous raiment. Let the class express in pencil, crayon and water color the varied beauties of November.

STUDY IN SEED VESSELS

So many of the interests of November circle around the home that we may well give them special thought for this month. The preparations for winter made by plants, insects, animals and man serve as suggestive motives to be incorporated into the art work.

From the morning talks develop interest in the following subjects: Pictures comparing nature in October and November (the trees, the skies, the ground); collecting nature's stores for use in winter (fruits and vegetables, nuts and grains); Nature's treasure caskets (seeds and seed pods). Ask the children to collect and bring to school the various



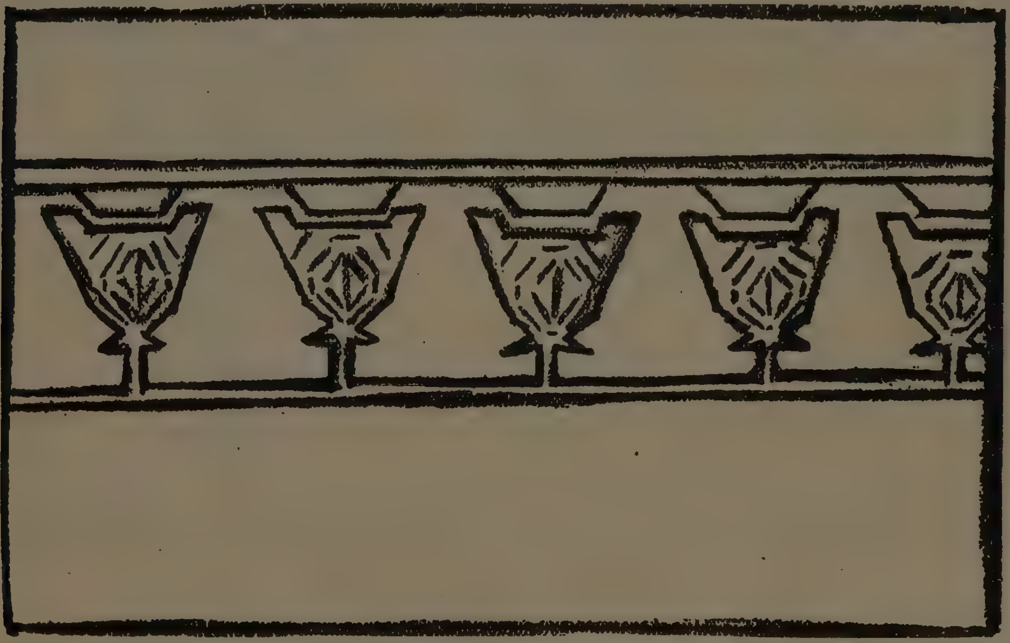
DESIGN FROM INDIAN MALLOW

weeds having seed pods—the milkweed, the teasel, the Jamestown or jimson weed, the cat-tail, the thistle and the Indian mallow. Consult Section 8, page 372.

28. First Week. Seed Pods on Branches. Use manila paper 9 x 12, pencil or crayons.

Place the nature material where all the pupils can see it. The class should study the general direction of stems, the angles between the branches, the character and form of the pod, how the pod is attached to the stem, and other distinguishing features of the study. Draw marginal lines on the paper to give an idea of the proper space in which to draw the study. If the branch is long and slender, draw a panel shape, that is, a long oblong, folding the paper to indicate the required shape. The pupils should sketch in lightly at first, to show the stems and the shape of the pods. If the surface of the pod is rough or smooth, try to show that effect in the shading of the pod. If the pencil is used in the first expression, try the colored crayons in a second lesson.

Save these drawings to use for design work in December. Save also some of the seed pods for use again. In the meantime they will make beautiful winter bouquets.

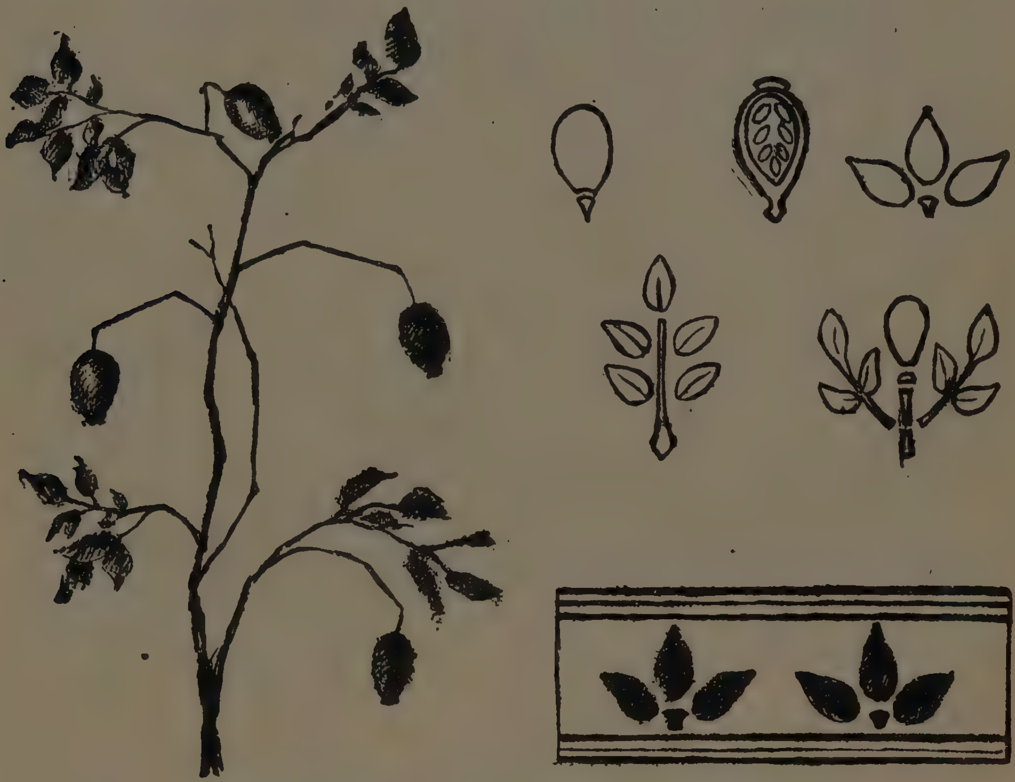


DESIGN FROM INDIAN MALLOW

29. Second Week. AUTUMN BERRIES. The rose hip or berry, the bittersweet, the green brier, the Judas berry and the poke berry are included under this title. Manila paper and colored crayons or water colors are good material for these studies.

If the colored crayons are used, see that the pupils match the colors as nearly as possible. They should also try to show the effect of light and shade in the berries, by adding some blue and brown on the shade side, even of the red berries, allowing the light paper to show through for the effect of light and high lights. If water color is used, it is a good plan to make a light wash of blue to show the shape of berries, and to drop in the bright color while the first light blue wash is still wet. Be sure that the brush is held upright in making the slender stems and leaves.

Save these drawings and the nature material for use later in design work. See illustrations for suggestive treatment.



ROSE BERRY AND UNITS OF DESIGN

30. Third Week. Fruits and Vegetables. Use colored crayons or water colors. Ask the children to bring to school a pumpkin, a squash, potatoes, onions, apples, pears, or ears of corn in the husk. If the children have had only a little of this work, select for use the larger, simpler forms, in the order given in the list. Water color is the easier medium to use in representing the pumpkin or squash; but the colored crayons can be used. See Color Plate Two.

Place the object on your desk or on a chair placed on the desk, so it will be plainly visible to all. Study the general shape of the object. Is it round, or longer than wide, as illustrated in the pumpkin and the squash?

If working in water color, take the brush full of the proper color, and, starting in the center, make the mass the shape to represent the object. *Do not outline* the object and then fill it in, for there is no outline to be seen, and the color should show the shape of the object. Add a little of all these colors to represent the dark side of the object. If colored crayons are used, try taking a piece of crayon about an inch long and putting it flat on the paper; mass it in as you do in blackboard work. See illustration of the squash in color. Let the pupils try representing the large vegetables on the blackboard.

STUDY IN VEGETABLES

If the study of the corn is used, hang one or two ears from a nail, fastening them by some of the husks. This study is the most difficult of any of the vegetables enumerated, and should be used by upper grades only.

The study of the corn can be expressed in pencil, colored crayons or water color. If pencil is used, make a careful outline drawing first, then show details of the ear, and shade with slanting strokes. If colored crayon is the medium

Plate Two

THE CROOKNECK SQUASH

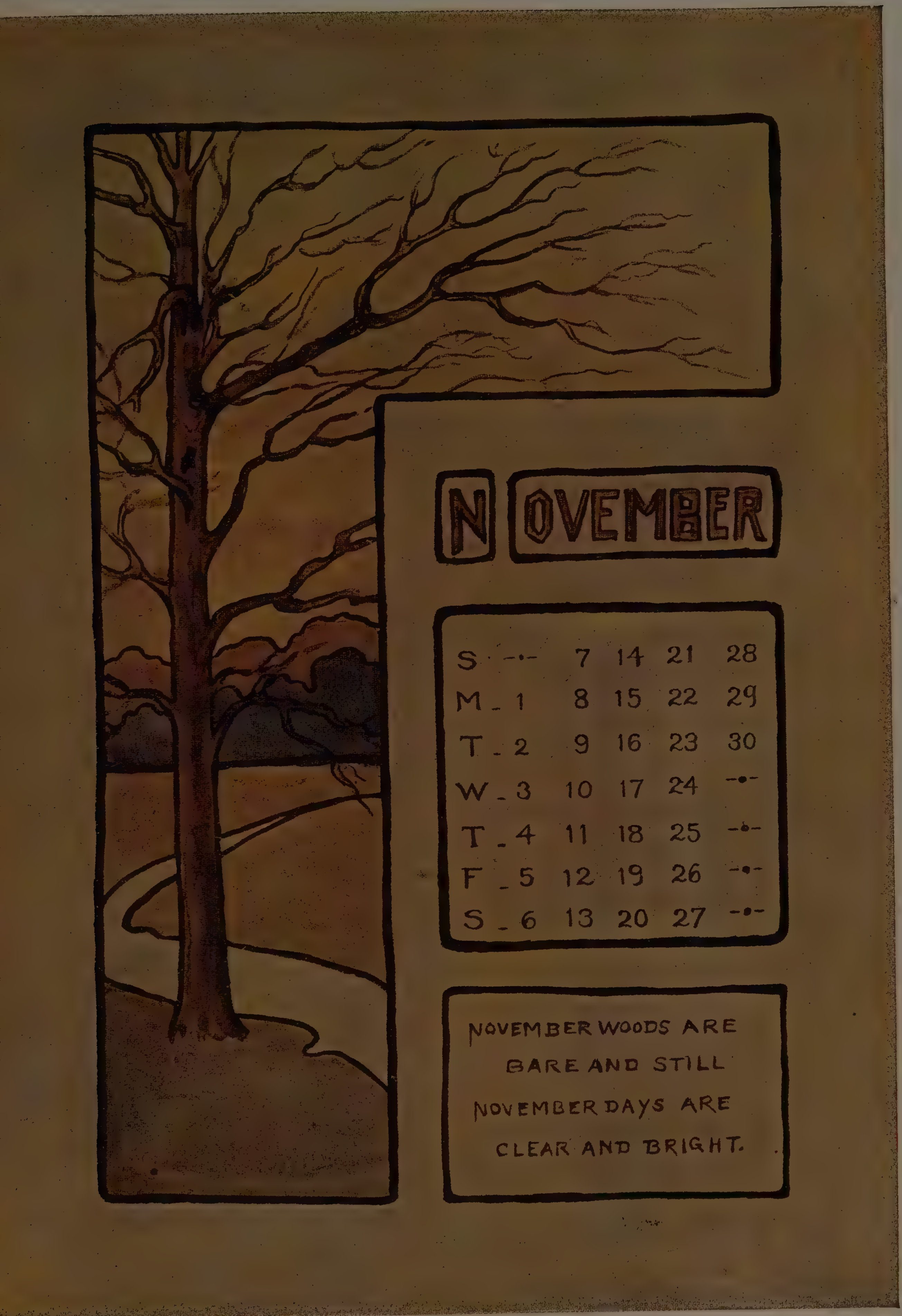
employed, mass in with the proper color, and then use darker brown to show the dark effects between the rows of kernels. Do not try to show all the marks between the kernels, but try to express the effect obtained by looking at the ears with eyes half closed. This shuts out all the small details, and gives the essentials which are necessary. When the drawings are completed, have the pupils hold them off at some distance and compare them with the study.

If potatoes or onions constitute the studies, the best medium to use is the pencil or black crayon. These are also good subjects for brush and ink work. See illustrations of vegetable studies.

31. Fourth Week. (a) OUTDOOR STUDIES. Collect pictures that suggest November and the Thanksgiving season. First secure those that suggest November landscapes. If someone has a camera, pictures of the surrounding neighborhood can be taken. But work from the window scenes can be done successfully. Ask the pupils to notice the different pictures they see in looking from the different windows. Sometimes a view from one pane of glass in a window will give a beautiful motif for a composition. A bare tree, carefully studied and drawn, makes an attractive study. Notice whether the tree sends a trunk through its entire length, or subdivides into many branches. The former is called the *excurrent* type, while the latter is the *deliquescent*. (See drawing of the elm, page 391.) Ask the pupils to name the trees they can think of that are like each of these types. The Lombardy poplar, the trees of the evergreen family, the beech, the sycamore, and some oaks are excurrent in type, while the greater variety of forest and cultivated trees, including fruit trees, maples, most oaks, the elm, the cottonwood and some others, are deliquescent in type. Next observe the arrangement of the branches. Are they opposite or alternate? Notice the angle which the branches form with the trunk. Show the irregularity of the little branches and twigs.

(b) CALENDAR. Plan a November calendar as suggested by Color Plate Three. Perhaps you can suggest some squirrels in the trees. Plan the spaces for the illustration, the poem and the calendar, to produce a pleasing arrangement. The pencil or water colors may be used appropriately in making the November calendar. If possible, give space

STUDY IN INDIAN CORN



NOVEMBER

S	-•-	7	14	21	28
M	1	8	15	22	29
T	2	9	16	23	30
W	3	10	17	24	-•-
T	4	11	18	25	-•-
F	5	12	19	26	-•-
S	6	13	20	27	-•-

NOVEMBER WOODS ARE
BARE AND STILL
NOVEMBER DAYS ARE
CLEAR AND BRIGHT.

Plate Three CALENDAR

on the blackboard for a calendar with suggestive illustration for each month.

(c) THANKSGIVING TEXT. While the fifth and sixth grades are making an illustrated calendar, the upper grammar grades can plan, and make a beautful illumined text. For plan, see Color Plate Six.

Choose some text in harmony with the thought of the season, and on paper lined in small squares plan the words of the text in plain letters. Use simple block letters, or, if you prefer, a more ornamental type, such as the Old English or Gothic style, may be used. The titles of books and magazines will furnish good examples of printing. Ask the children to look in newspapers for plain block letters.

The design will be more attractive if some of the fall nature studies are used to decorate the text. The berries, seed pods, or the Thanksgiving flower—the chrysanthemum—could be used. To make the nature study suitable for such a decoration, draw it carefully and apply the color in a flat wash on flower and leaves; then, when that is quite dry, outline each part with a strong black line, using black water color.

(d) CORRELATIONS. If the children are studying colonial history, it would be interesting for them to make a sketch of the "Mayflower" in a decorative treatment, to use as a cover for their written exercises in this branch.

(e) MOUNTING. Give the pupils an opportunity to mount their drawings and paintings on large size manila paper, 9 x 12, and make an exhibit of the work done in November.

Test. Make a study of a seed pod on the stem, in pencil; also a study of a vegetable, in pencil or crayon.

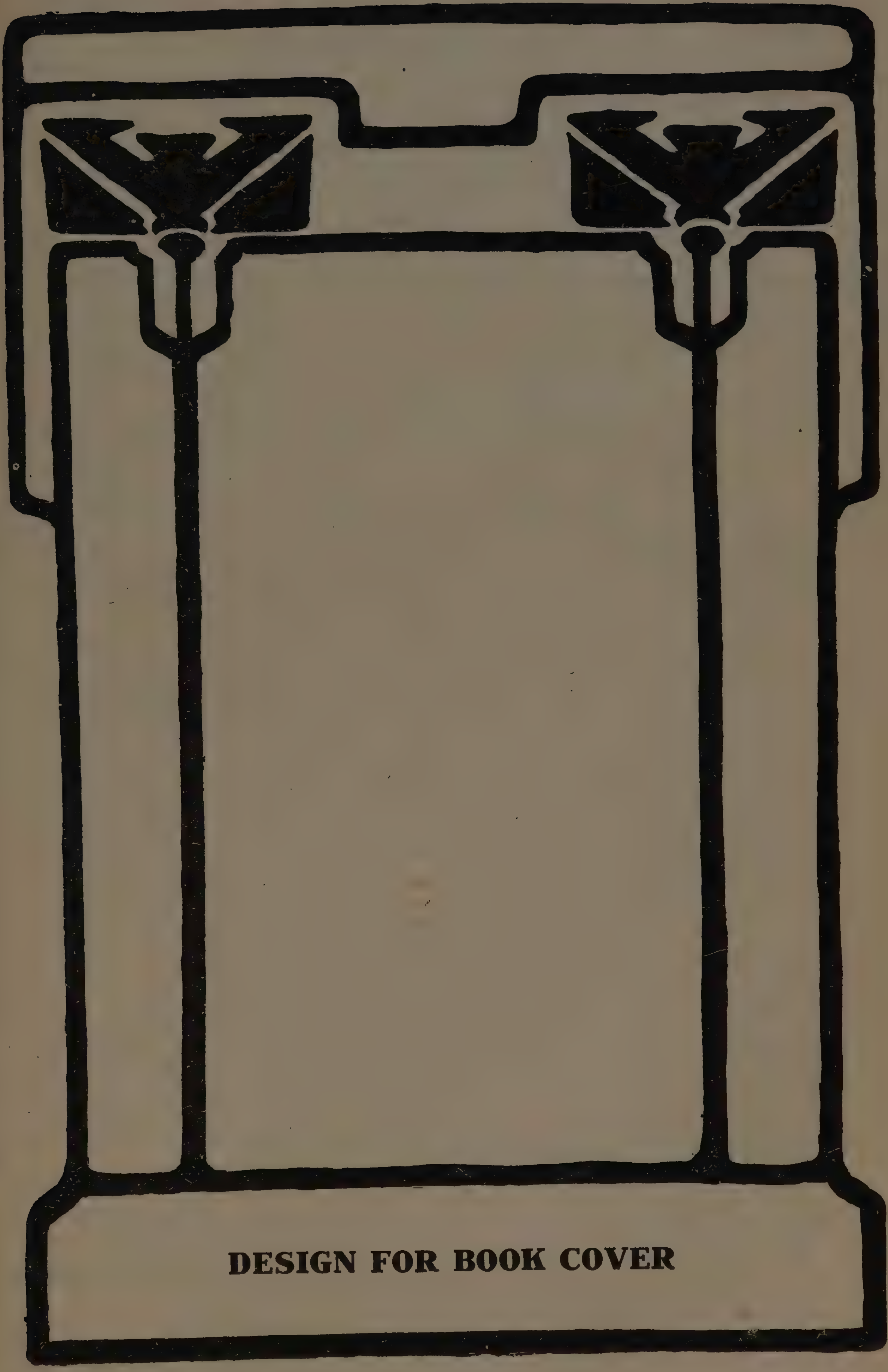
Draw something appropriate for Thanksgiving.

DECEMBER

The world is happy,
The world is wide;
May joy be yours
This Christmas-tide.

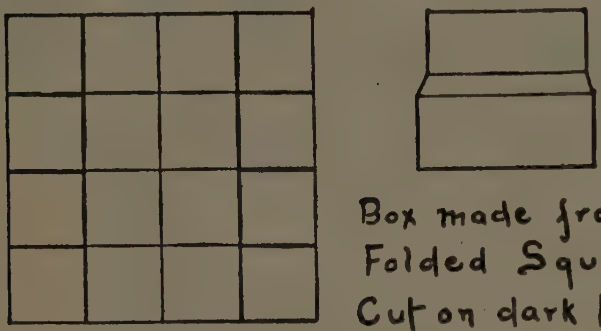
Holiday Greetings

"This learned I from the
Shadow of a tree
That to and fro did sway upon
the wall—
Our shadow selves, our
influence, may fall
Where we can never be."



DESIGN FOR BOOK COVER

32. Construction Work. Let the work of this month be influenced by the interest of the children in preparing gifts for the Christmas festival. This work will afford some good problems in constructive and decorative design. Instruction should be given to aid the pupils in constructing objects from working drawings. When a working drawing is introduced in this way, its function is readily understood. It means little to the child to make a working drawing of an object, if, in the end, that drawing is not put to some definite use. Through conversation with the children, learn some of the things they would enjoy making, to use as holiday gifts. You might volunteer such suggestions as a candy box, handkerchief box, glove box, work basket, scrap basket, decorated calendar, illuminated Christmas texts.



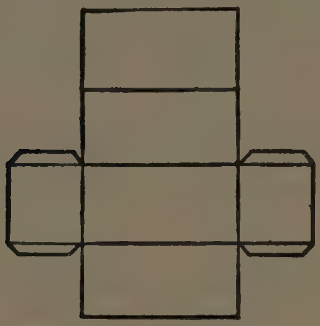
Box made from
Folded Square
Cut on dark lines.

33. First Week. (a) Working Drawings. Explain to the children that when any object is to be constructed, either large or small, from a house to a small box, that drawings are first made which give all the facts and details of the form of the object. These are called *working drawings.* The size, proportions, decoration and materials used are fully explained in connection with a working drawing.

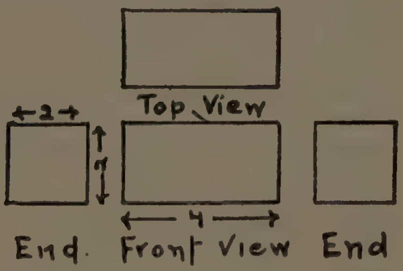
Working drawings may represent different views of the object, as the front and side elevations of a house, showing the placing of doors and windows, and shape of the gable; or they may show the development of the whole surface, as a pattern of a dress, or of a box to be made of cardboard. This method is usually employed when objects are to be made of flexible material, such as paper, cloth and tin. Patterns are used as working drawings. When objects are to be constructed of wood, stone and other inflexible material, different views of the object, with measurements, are then given.

To illustrate the making of a pattern, or to show the development of the surface of an object, which is the same as a pattern, a very simple problem may be given to the children in the development of the surface of a box.

The box has a top, bottom and four side faces, so the pattern must have six faces, or sections. Folding a paper over a box, and creasing the sides along the edges, will show the proper placing of these faces, in relation to each other.



Pattern for Box –



Working Drawing of Box

A simple pattern may be developed by folding a square of paper into sixteen small squares. Fold it first on its diameters, then fold the upper and lower edges *to* the diameters, thus making sixteen small squares. Now cut on the folds between the squares, and lap the squares not needed in the actual surface of the box. See the illustration, page 416. From a pattern thus developed, made of cardboard, a candy box can be constructed and covered with bogus paper or any other paper you wish to use.

(b) Making Boxes. The materials necessary for box making will consist of cardboard, rulers, scissors, paste and cover paper, which may be the ordinary manila drawing paper, colored paper, bogus paper, or plain colored wall paper. Ask the children to bring old pasteboard boxes to school to be used in making gift boxes.

If a glove or handkerchief box is desired, let the pupils consider the size and proportion of these boxes best suited to the shape of the objects they are to contain. A square box is most suitable for handkerchiefs, and a long, narrow box for gloves. A handkerchief box should be 5 inches wide, 5 inches long and 2½ inches deep. A glove box should be about 8 inches long, 3 inches wide and 2½ inches deep, according to the size of the handkerchiefs or gloves.

For the handkerchief box, measure on the cardboard, with the ruler, and draw the various faces of the box, making the top and bottom faces 6 inches square, to allow a half inch projection on all sides, and four pieces 5 x 2½ inches, for the sides of the box.

For the glove box, cut two pieces 9 x 4 inches for top and bottom; two pieces 3 x 2½ inches for the ends, and two pieces 8 x 2½ inches for the sides.

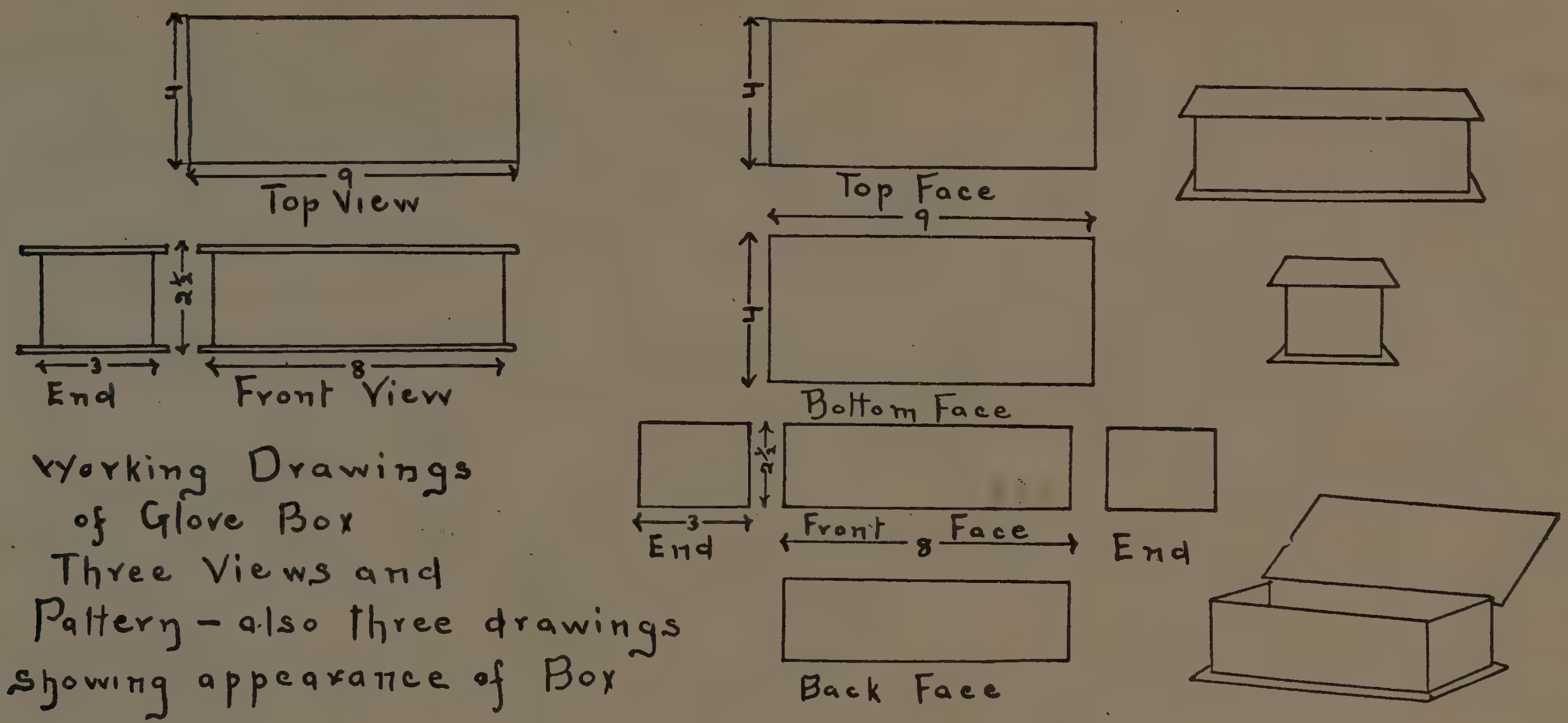
The next step is to cover the separate pieces with the cover paper. Lay each piece of cardboard on the cover paper, and mark around it. Allow a half inch for laps around all sides of these cover pieces. Fold the laps over the edges of the cardboard, and paste the four laps over on the top and bottom faces of the box; but on the remaining sides paste down one long and one short side only. The remaining laps will be pasted to each other to hold the box together.

The top and bottom pieces of the box should be covered on both sides with cover paper, and the inside of the box should be lined with a long strip of paper to fit each side. The lining paper at the back should be allowed to extend above the edge of the box one-half inch, and this should be pasted at the back edge of the top of the box to serve as a paper hinge.

The beauty of the work in construction will depend upon its accuracy and neatness.

(c) WORK BASKET. If a work basket is to be constructed, a pattern may be developed by drawing a hexagon for the base, and having the six sides fastened to it and to each other.

Draw a circle with a radius of 2 inches. If compasses are not at hand, make a simple compass by taking a strip of cardboard and placing a pin at one point, and push a pencil



Working drawings are drawn to a scale; that is, they are made proportionately larger or smaller than the object. The drawings for small objects, like the works of a watch, are made larger, and those for large objects, like parts of a wagon, are made smaller than the object. The measurements of working drawings must be exact.

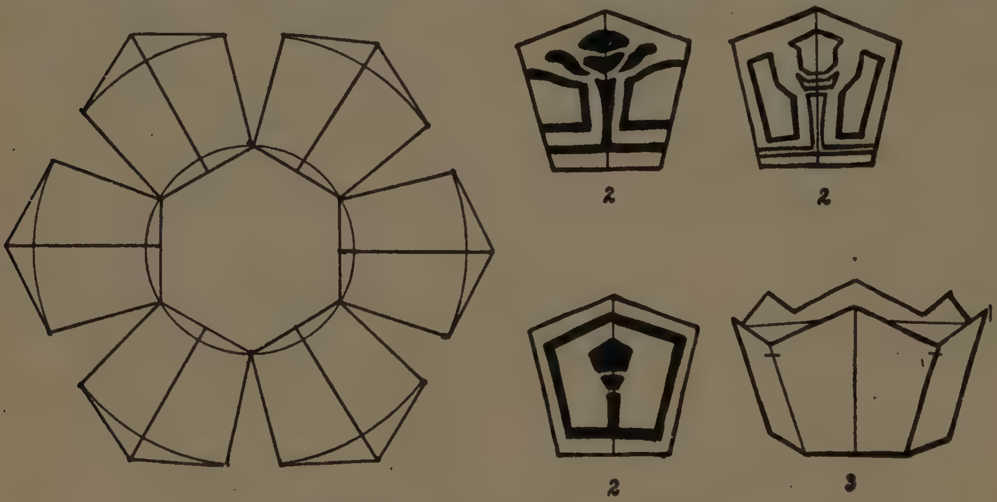
Working drawings deal with the facts pertaining to the construction of an object, and not with the appearance of the object.

Five kinds of lines are used in working drawings:

(1) Center lines. indicated by a dot and a dash .-.-.-.- They are also called construction lines.
(2) Full lines, representing visible edges ————.
(3) Dashed lines, representing invisible edges - - - - - -.
(4) Dotted lines, connecting views . . . . . .
(5) Light lines, indicating measurement.

point through a small hole made in the cardboard, at the distance of the radius of the required circle from the pin. The circle may be described accurately with this simple device, by swinging the pencil around the pin as a center. Divide the circumference into six equal parts, by using the radius as a unit of measurement, making a hexagon. On a two-inch base construct the sides of the basket, making them 3 inches in height and 3 inches in width at the widest place.

After the hexagon base and six sides have been cut from cardboard, cover them with colored paper or cloth, using plain gingham or linen, and sewing over and over nicely for this purpose. The same is used as in covering the sides of the box previously described. If cloth is used, the cover may be sewed over and over with fine stitches and thread to match. The sides may then be stitched together, and then stitched to the base. If paper is used, instead of fastening the sides by pasting the laps in place, as you did in making the box, they may be held in place by a cord passing through holes punched in each side of the six faces, and tied together in this manner. See illustration of basket.

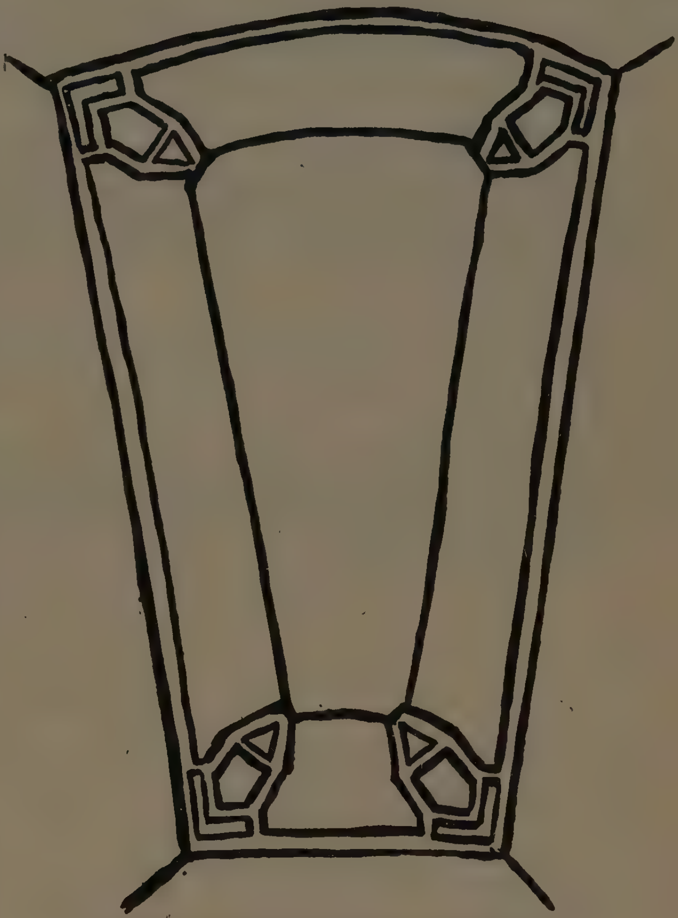


1. PATTERN FOR WORK BASKET
2. DESIGNS FOR BASKET
3. APPEARANCE OF BASKET

(d) Waste Paper Basket. Construct a waste paper basket having a base 4 inches square, and four sides each

12 inches long, 4 inches wide at the base and 8 inches wide at the top.

Draw the pattern and make the basket of cardboard, and cover it with paper as described in previous problems in construction work. Plain or figured wall paper may be used for covering the baskets. Some children may wish to bring remnants of wall paper from home so the basket will match the paper in their home, and their wishes should be respected. In general, however, the plain paper is to be preferred.



DESIGN FOR WASTE BASKET

34. Second Week. (a) DECORATING BOXES AND BASKETS. The most appropriate decoration for the boxes and baskets will be obtained by studying the nature material we used in the art lessons during the fall. The leaves, flowers, nuts or seed pods, berries, and holly, with its bright red berries and dark green leaves, are all appropriate.

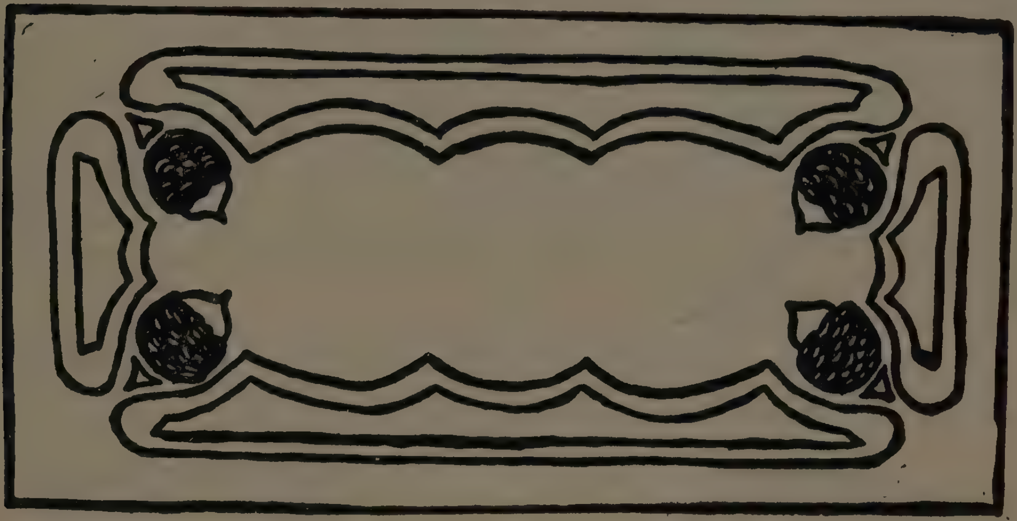
While the units to be used in the designs may be suggested by nature subjects, they should not be copied in their natural forms. Each unit should be adapted to suit the needs of the design. Illustrations may be given and worked out by the children, as the plates of design units from the rose hip and Indian mallow suggest. See illustrations.

Ask the children to select for a border design some unit from the subjects studied during the fall, such as a leaf, a flower, or a seed pod; then assist them to modify and apply this unit in accordance with the plans shown in the illustrations. After a unit has been selected, consider the space to be decorated, and make such an adaptation of the unit as will produce the most pleasing effect. If the space is small, as the side of a work basket, a single unit or a row of units may be chosen, making a border, as suggested in designs for the top of the box. Another good design can be made by filling the corners, connecting them with lines, as the design for the scrap basket suggests. Again, the surface may be covered, as the design of milkweed pod suggests.

DESIGN FOR BOX COVER

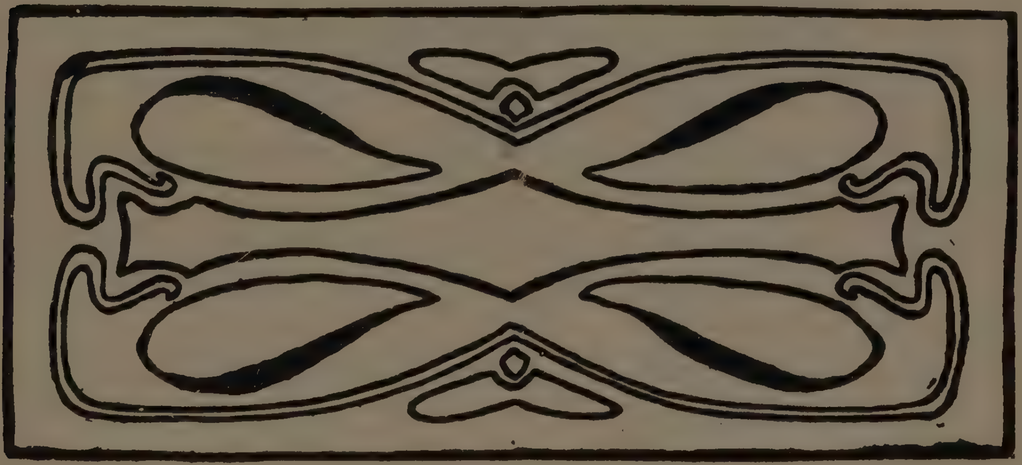
(b) Conventionalized Forms. A design worked out from a nature motif, as suggested above, is said to be a *conventionalized* form, that is, a nature unit made conventional, or formed for use in design. This method of adaptation of nature's forms is in accordance with the principles of good design, but to copy a nature form without adapting it to the form of the object to be decorated is a violation of these principles.

In a conventional design all irregularities of growth are omitted, the aim being to produce a perfect form that will be graceful and symmetrical and yet show clearly the form from which it was taken. It should always be adapted to the use to which it is to be put. If it is to be used in a border, or in a surface covering, it must be so arranged that a repetition of it will produce a harmonious effect. Study the illustrations given on pages 402 and 403.



DESIGN FOR BOX COVER

Many objects to be found in the stores are decorated (so called) by the mere copying of flowers, figures or landscapes in a naturalistic treatment, but these decorations can in no sense be called designs, or even good decorations.

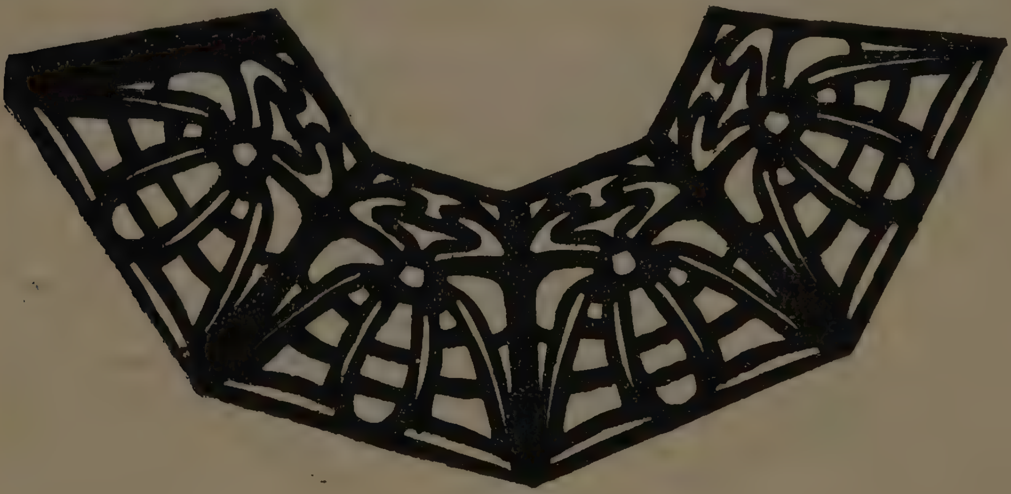


DESIGN FOR BOX COVER

From time to time give the children talks on what should constitute a good design, and call attention to the many violations of the canons of good taste in the objects found in the stores. China ware is not decorated in the best sense of the term by the painting of flowers, heads, figures or landscapes, rendered in a naturalistic way. Such decoration belongs to the field of picture making, and is not true decoration of objects.

(c) APPLICATION OF DESIGNS TO OBJECTS. After a design has been made for the box or basket constructed by the child, it can be transferred to any object by the use of transfer paper, by a tissue paper copy made and drawn over the lines, or by a stencil.

A *stencil* is a pattern so cut as to leave the design in open spaces, through which a drawing or painting may be made.



LAMP SHADE

Care should be used to have each part of the design separated by a little space, if a stencil is to be cut, or the pattern will fall to pieces.

It is well at this point to show the pupils how to transfer their designs by each of the methods given. Let them apply the design to the object, and paint the same with flat tones, in harmony with the color of the cover paper. It is not necessary to imitate the color that nature suggests, but if such coloring is chosen, let each color be grayed by using a little of all three colors, to make a harmonious combination. Tones of the color that the cover paper suggests make a very pleasing effect.

35. Third Week. This week is usually the closing one before the holiday season, and may be profitably spent in any of several ways.

(a) DECEMBER CALENDAR. A calendar for this month may be decorated by using a winter landscape or some nature subject which suggests the season. A branch of holly, or of fir with cones, or the beautiful poinsettia may be chosen. Ask the children to bring a calendar pad and a piece of cardboard. Cover the cardboard with colored paper, and mount the picture you have made, together with the calendar pad, upon it. Paste a loop at the top, or paste a piece of cardboard to the back to make it into an easel, so the calendar will rest on the table. See the illustration for November calendar, Color Plate Three.

(b) WINTER POEMS. Read to the children some beautiful poem about winter, and ask them to illustrate it. One suggestion is from *Snow-Bound* (Whittier), the selection beginning:

> So all night long the storm roared on;
> The morning broke without a sun.

Others in which good material may be found are *The First Snow Fall*, Lowell; *Winter*, Trowbridge; *December*, Emerson.

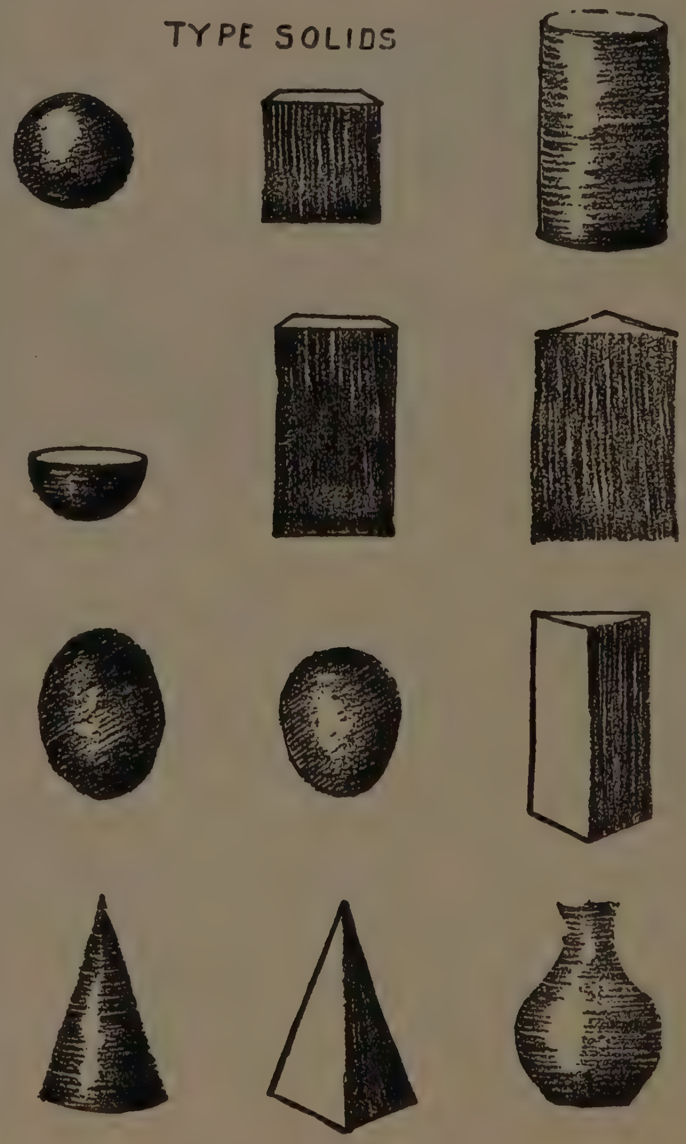
(c) ILLUMINATED TEXTS. If it is desired, appropriate Christmas texts may be made by children in upper grammar grades, as suggested under work for November; or printed texts may be used and illuminations made in color.

Some very beautiful texts are made expressly for this purpose, and are quite inexpensive. These cards are printed in decorative type, and the decoration is carried in outline, which may be filled in with color by the children. The text may be further embellished by use of gold paint in outlining the decoration. These cards give the children some excellent examples of beautiful painting, and show how nature forms may be adapted to the use of design. Such cards may be procured of Miss Nellie Trufant, 2614 Clinton Ave., Minneapolis, Minn., or of Atkinson-Mentzer Co., 2210 South Park Ave., Chicago.

Test. Make a working drawing of a square handkerchief box, 5 x 5 x 2½. Make a design for the top of a box, using a 5 x 5 square. Use a conventionalized nature form—seed pod, holly berries or other appropriate decoration.

JANUARY

A Happy New Year, a Happy New Year,
Oh send it afar,
To the girls and the boys wherever you are;
To the rich and the poor, the high and the low,
Oh! scatter its blessings wherever you go.



36. First Week. (a) Vacation Studies. We have all enjoyed the holiday season, and now return to our work with renewed energy and a desire to get the most out of the new year. The children will be interested in telling you of their Christmas joys. Let them illustrate with crayons, pencil or brush, something they did during vacation. Illustrate sliding down hill, skating, snow-balling, helping mother or father. Try making a January landscape with the poem on the blackboard.

(b) Solids. We are surrounded by

a world of objects that become more interesting as we become more familiar with them. We have given special attention during the fall months to the objects in the world of nature. We will give special regard during the next two months to the objects in the world of arts and manufactures. All objects are modified forms of a few types. Froebel classified all forms under three types, namely, the sphere, the cube and the cylinder. Ask the pupils to name a number of familiar objects resembling the sphere, as, fruits, vegetables, etc.; objects like the cube, as blocks, boxes, baskets, stools, tables, buildings, etc.; objects like the cylinder, as tree trunks, stems and some flower forms, besides many manufactured objects, such as bottles, jugs, pails and barrels. After a little study, the children will discover that many objects only remotely resemble any of these types, and so for convenience other types have been added, which are modified forms of the first three. The complete list is as follows: sphere, cube, cylinder, hemisphere, square prism, right-angled triangular prism, ellipsoid, ovoid, equilateral triangular prism, cone, square pyramid and vase form. There are twelve in all, and for convenience they may be divided into groups of three. Name objects like each.

(c) DEFINITIONS. Describe each form as to kind and number of faces, edges, etc., as follows:

The *sphere* has one round face.

The *cube* has six equal plane square faces, twelve straight edges and eight corners.

The *cylinder* has two plane faces and one curved face and two curved edges.

The *hemisphere* has one plane face and one rounding face, and one curved edge.

The *square prism* has six plane faces, two square faces and four oblong faces.

The *right-angled triangular prism* has five plane faces, and the two ends, or bases, are right-angled triangles.

The *ellipsoid* has one rounding face having two rounded, small ends.

The *ovoid* differs from the ellipsoid by having one end larger than the other, being egg-shaped.

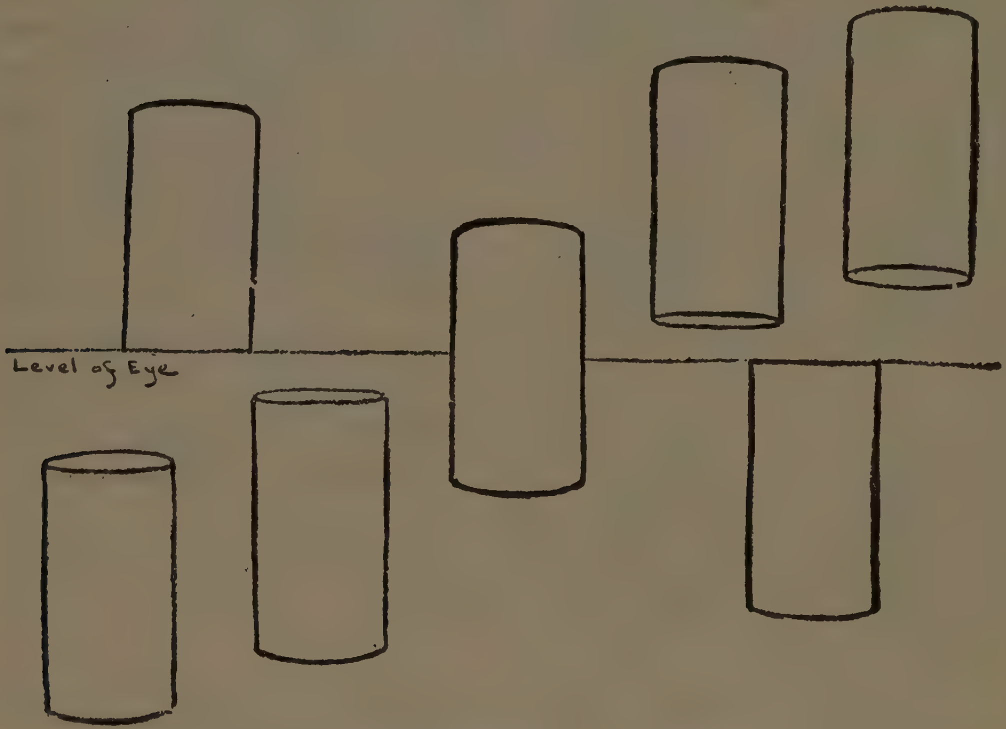
The *equilateral triangular prism* differs from other prisms by having equilateral triangular ends, or bases.

The *cone* has one plane face and one curved face, and one curved edge.

The *square pyramid* has a plane square base, having four equal plane, triangular faces that meet at a common point called the vertex.

The *vase form* has two plane faces and one rounding face having reversed curves.

(d) PERSPECTIVE. The study of the appearance of form and representing forms as they appear, without regard to facts of form, is called *perspective.* All objects may be grouped under two heads in the study of perspective, namely, cylindrical perspective and rectangular perspective.



CYLINDER IN DIFFERENT POSITIONS

Cylindrical perspective deals with objects that resemble the cylinder, having curved edges.

Rectangular perspective includes the study of objects having rectangular faces and straight edges.

After the children have had a number of lessons on the study of types of form, ask them to make a cylinder by rolling a piece of 6 x 9 manila paper, and pinning it in place. Ask the children to hold the cylinder upright, at arm's distance, and observe the changes in the apparent form of the top and bottom faces. Hold it out so that the top edge is on the level of the eye. Lead them to observe the essential points by such questions as these: How does the circle appear in that position? (Answer: A straight edge.) How does the bottom edge appear? Put your pencil under the lower edge, and notice the downward curve of this edge. Could you draw the picture of the cylinder in this position? Draw what you see, on the paper and on the blackboard. Again, try placing the cylinder with the bottom edge on the level of the eye, and draw what you see. Place the cylinder below the level of the eye, about on a line with your shoulder; can you see into it? How does the circle appear now? (Answer: A narrow ellipse.) Place the cylinder still lower; how has the top changed in appearance? (Answer: It appears a wider ellipse.) Now place the clyinder above the level of the eye, and watch the gradual widening of the ellipse at the bottom. Carry these observations far enough to establish these principles regarding the appearance of the circle:

(1) The appearance of the horizontal circle on the level of the eye is a straight edge.

(2) When the circle is seen obliquely above or below the level of the eye, it appears an ellipse.

(3) The nearer the horizontal circle is to the level of the eye, the narrower the ellipse appears.

(4) When the horizontal circle is seen directly above or below the eye, it appears as a full or complete circle.

Draw the cylinder with relation to the eye-level in the following positions, and note the change of appearance of the circular bases.

(1) Draw the cylinder with the top on the level of the eye.
(2) Draw the cylinder with the bottom on the level of the eye.
(3) Draw the cylinder with the middle on the level of the eye.
(4) Draw the cylinder a little above the level of the eye.
(5) Draw the cylinder a little below the level of the eye.

Draw a horizontal line across the center of the paper, to represent the level of the eye, and draw the cylinders in relation to that line. See the illustration of the cylinder in different positions.

Caution. It will be well to give the foregoing study of type solids slowly, according to the ability of the children to receive it. The first group may be given the first week, the second group of three the second week, and so on, letting the work cover the whole month, if necessary.

37. Second Week. APPLICATION OF PRINCIPLES. After the pupils have a working knowledge of the principles learned in studying the cylinder, ask them to bring to school objects resembling the cylinder—a tin cup, a pail, a crock, a jar, a flower pot, a jug. Use also the objects found in the schoolroom—the cup, pail and dinner pail.

Study the proportions of each object. Proportion is the relation of height to width. Teach the children how to find proportions by measuring on their pencils, held at arm's length, with one eye closed. Hold the pencil vertically at arm's length, allowing the top of the pencil apparently to touch the top of the object, and let the thumb indicate on the pencil where the bottom edge comes; this shows the apparent height of the object. Now, with the pencil held

CYLINDRICAL OBJECTS IN OUTLINE

horizontally, compare the apparent width with the apparent height.

Use manila paper for sketching, and draw several of these simple objects in outline. Draw two light lines to suggest the height of the object, then two lines to suggest the proportionate width. Make the sketch as large as will suit the size of the paper. Look carefully at the proportions of the ellipse at the top, if the object is placed below the line of the eye; and if placed above the eye level, as on the teacher's desk or upon a box or chair placed on the teacher's desk, notice the upward curve of the upper edge. What kind of a line will you draw to represent the base, if the object is above the level of the eye? (Answer: If it is on a box above the eye level, draw a straight line to represent the edge of the box. If the object is below the eye level, indicate the downward curve at the base.) Draw from various objects

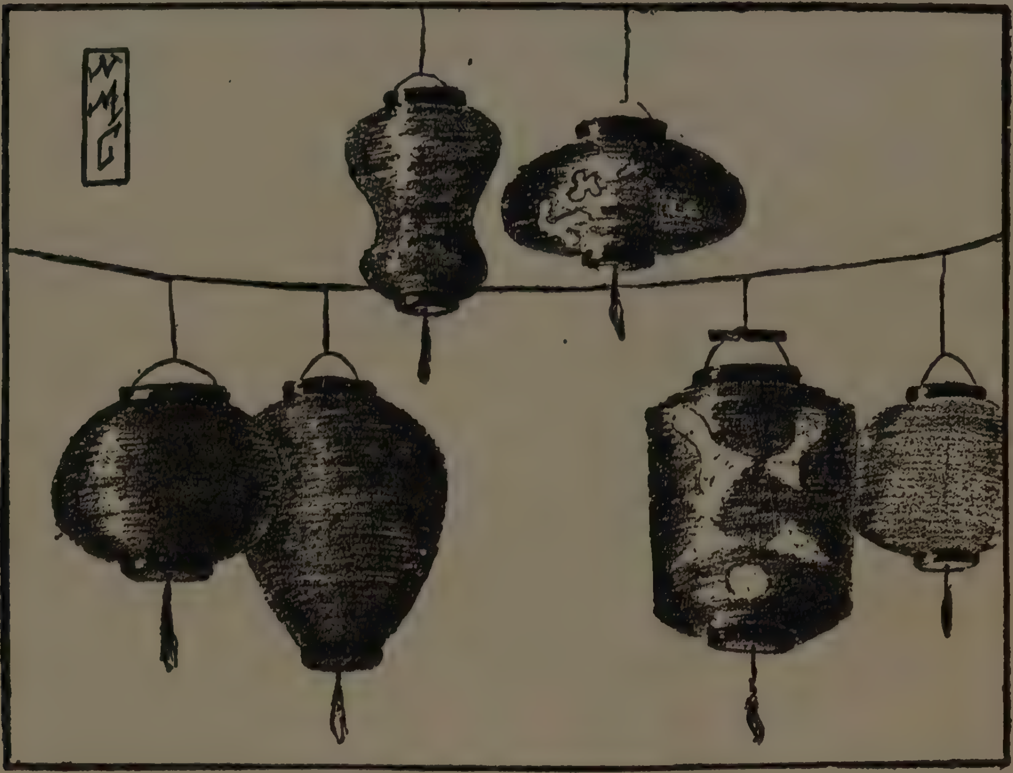
STUDY IN LIGHT AND SHADE

in outline, using pencil and manila paper. See illustration of objects drawn in outline.

38. Third Week. OBJECT DRAWING. Objects showing dark and light color in the ware, crocks and jugs, brown and white bowls, furnish excellent studies. Use manila paper and pencil or crayon. Place the objects on boards between the desk, so that children along two rows can see the object well. One object placed in every other aisle will be sufficient, unless the object is small; then place two objects in the aisle, putting one half way down the length of the aisle on a board placed across the desks. By leaving an aisle entirely free, it gives opportunity for the teacher to pass through for class criticism.

STUDY IN COMMON OBJECTS

Sketch the outline lightly with pencil or brown crayon, first indicating by light, sketchy lines, called *blocking in*, the general proportion of the object. After the outline is sketched in lightly, study the object to see what parts are of dark color and which are light, then with pencil or crayon show by lines drawn parallel to the curve at the top, the dark part of the object. Is there a high light on the light side of the object? If so, look carefully at its shape and leave that spot the color of the paper.



LANTERNS IN LIGHT AND SHADE

Try several different objects, showing the effect of dark and light, as suggested by the illustrations.

39. Fourth Week. (a) OBJECT DRAWING (CONTINUED). The purpose of the study of objects this week will be to see and express the effects of light and shade. Use the same materials which were used last week. The objects must be placed to receive light from one side of the room; the window shades should be lowered at the back and other side of the room, if there should be windows on more than one side. Choose some light colored object; a flower pot, bowl, peck measure or bushel basket will be suitable. If the object is small, place it on the boards between the aisles; if large, it may be placed on the teacher's desk. Ask the children to observe the effect on the light side, and compare with the shaded side of the object. If you can see into the object, compare the color effect of the ellipse with the outside of the object.

Sketch in as before, and, leaving the light side the color of the paper, show the dark side by pencil or crayon shading, or painting with the pencil, as it is called. See the illustraions for January work.

(b) REVIEW. Review the work of the month by calling for blackboard work, making memory sketches from objects previously drawn.

Test. Name two objects like each of the following type solids: sphere, cube, cylinder, square prism, cone, triangular prism.

Draw a cylinder in five different positions with reference to the level of the eye.

Draw from a cylindrical object having a handle (a cup or a pail), placed below the level of the eye. Draw in outline.

Draw from a group, a tumbler and lemon. Use the pencil.

Write the principles pertaining to cylindrical perspective.

FEBRUARY

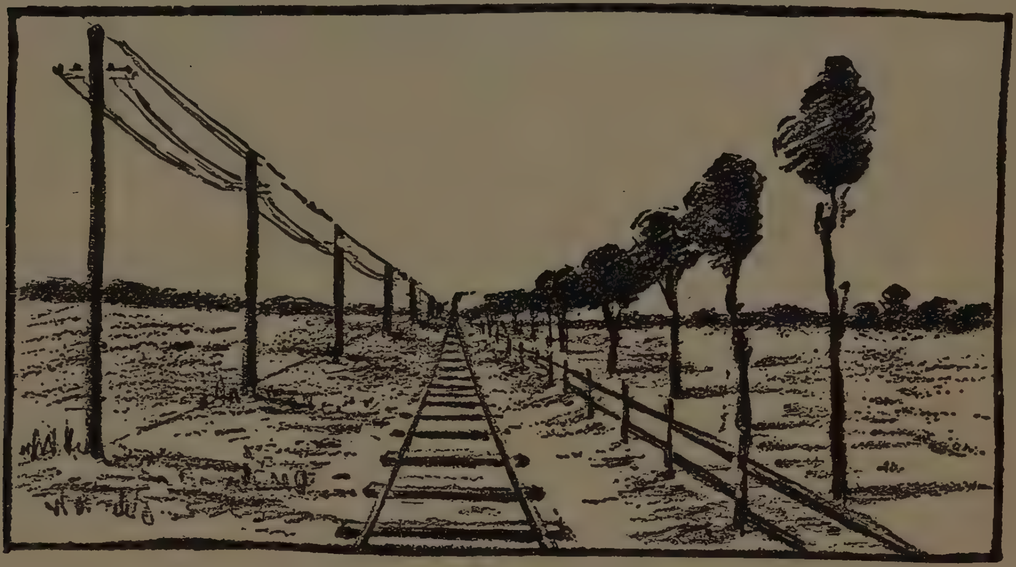
Sunset red and quiet air;
Ponds are ice and trees are bare;
Fields are frozen far and near;
February days are here;
Bitter cold the night draws down
On the country and the town,
But in cheerful warmth we sit,
And the nursery lamp is lit.

—*K. Pyle.*

40. First Week. (a) FEBRUARY POEM. Read the children this poem, descriptive of February, and ask them to imagine the picture. Then let them represent this picture with water colors or colored crayons, bringing out the sunset sky, the bare trees and ponds of ice. Some may like to picture the skaters on the pond. Perhaps the ground is white with snow; if so, leave the paper the natural color, to represent the white ground. See Color Plate Four.

Plate Four A WINTER LANDSCAPE

If the landscape is to be done in water colors, moisten the paper with one or two brushfuls of water, and tint the sky space to suggest a bright sunset, using red or red and yellow, blending the colors together, as you recall seeing them in an evening sky. Practice making bare trees, such as you can see from the window, on a dry paper, while the sky is drying a little. Then try the same on the first paper. Hold the brush upright, to get a fine, firm stroke for the little branches. The icy pond may be shown with a gray, blue-green color, made by mixing all three colors (blue, yellow and a little red). If the pupils have no water colors, a study in brush and ink work or colored crayons may be used. If these little landscapes are saved, each can be mounted with an appropriate verse for a valentine.



ILLUSTRATING APPARENT CONVERGING OF HORIZONTAL RECEDING LINES

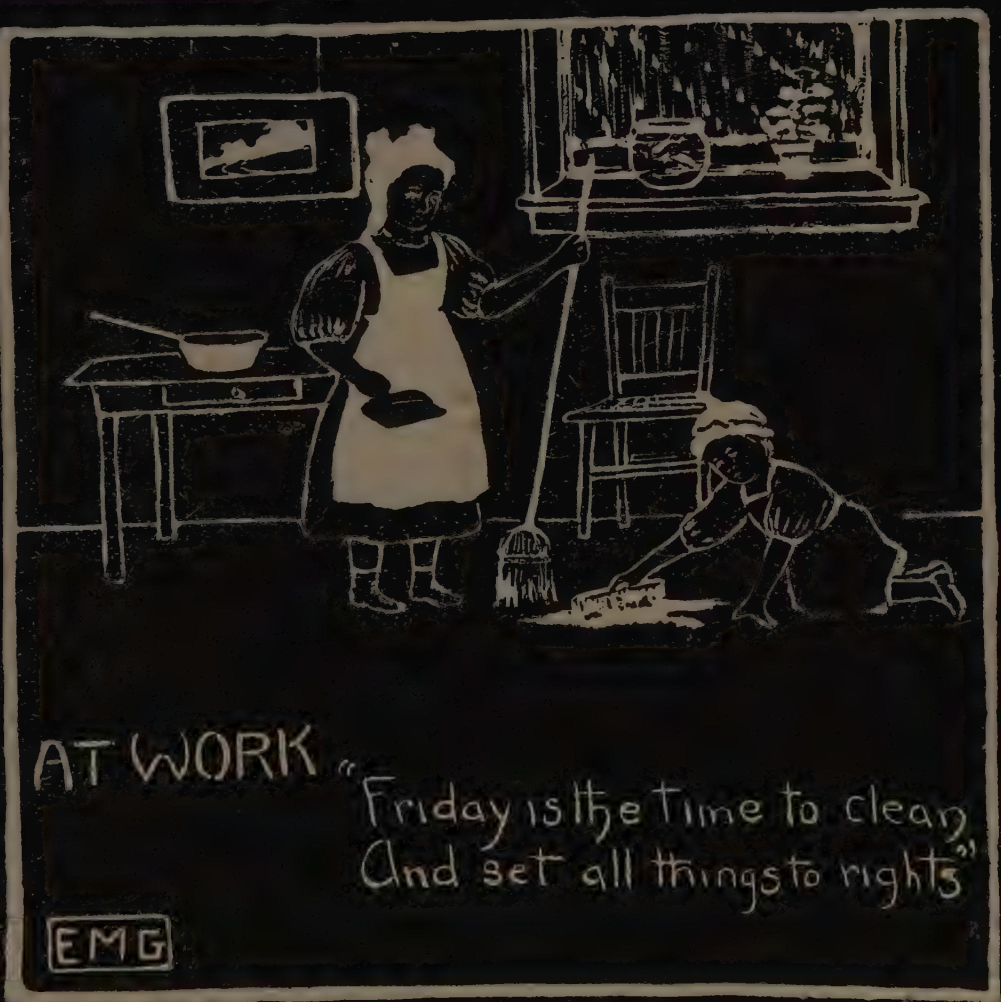
(b) Landscape Illustrating Perspective. Use the landscape to illustrate to the children the appearance of receding lines and edges as they are noticed in the road, railroad, telegraph poles, trees and houses in perspective.

By questioning, the children may be led to recall that the parallel horizontal receding lines found in railroad tracks, seem to converge or come together, and if you can see them at a great distance, they appear to meet at the horizon.

FEBRUARY

SUN	MON	TUE	WED	THU	FRI	SAT
						1
2	3	4	5	6	7	8
9	10	11	★	13	♥	15
16	17	18	19	20	21	★
23	24	25	26	27	28	29

GARDENING


AT WORK
"Friday is the time to clean
And set all things to rights"
EMG

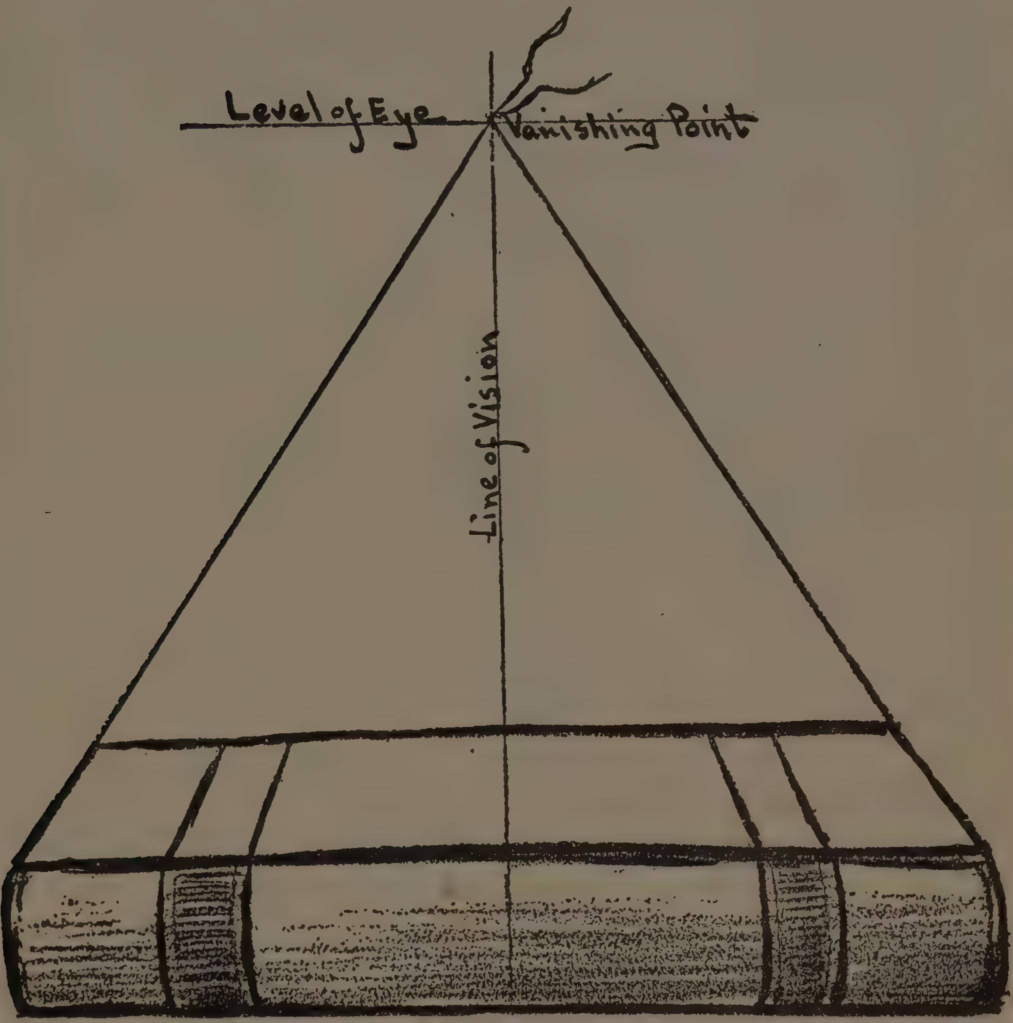
or eye level. Illustrate this principle by drawing a horizon line, and lines for track converging to a point. Add lines parallel to these lines, converging at the same point, to indicate lines for telegraph poles and trees at either side. Draw lines for tops of telegraph poles and trees, converging to the same vanishing point. Finish the sketch by drawing vertical lines for poles and trees, making the distance between them less and less as they approach the horizon. Finish by drawing in the details—telegraph wires on the poles, foliage on the trees, ties on the track, and other details of the landscape. Illustrate these points by drawing on the blackboard while the children follow with pencils and paper.

41. Second Week. RECTANGULAR OBJECTS. After the children have observed the appearance of parallel horizontal receding lines in the landscape features, it will be well to follow this exercise with observation of rectangular objects in the schoolroom.

(1) *Book.* To further demonstrate the principle that parallel horizontal receding lines appear to converge, and if sufficiently extended will meet at a point on the level of the eye, called the *vanishing* point, allow the children to make the following experiment:

Take a book and a long string; slip the string under the cover of the book close to the back edge. Now place the book as far away from the pupil as possible, resting it on the desk, with the back of the book toward the observer. Take the string at both ends, and by holding the ends of the string slanting toward each other, and closing one eye, adjust the string apparently to conceal the short, receding edges of the book. If the string is sufficiently long, the ends will cross at the eye level, proving the statement made at the beginning of this lesson. What was observed in the railroad is also true of even short horizontal parallel receding lines.

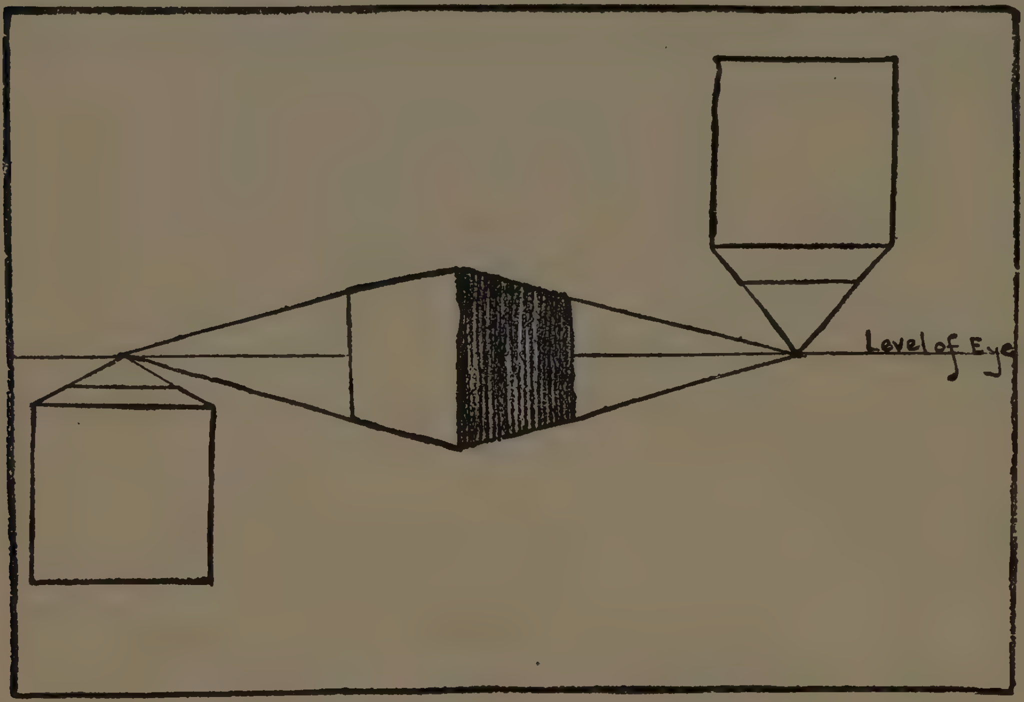
To find the apparent width of the face as it rests on the back of the desk, place a ruler upright on the back edge of the book, and let the finger or a pencil indicate how many inches wide the top face *appears*. Close one eye to make all these observations. With the strings in position again, the apparent length of the *farther* edge may be discovered by measuring between the two farther corners, on the ruler, placing it against the strings.



EXPERIMENT ILLUSTRATING CONVERGING OF HORIZONTAL RECEDING LINES

Make a large drawing of the book, dealing with the actual measurements of the back, and apparent measurements of the top. Use a comparatively thick book, as a school reader, for this exercise. If the drawing is made smaller than the actual size of the book, the measurements must all be reduced proportionately.

(2) *Cube.* After experimenting with the books and strings, next let the children observe the hollow cube. Fold a strip of manila paper, 2 x 9 inches, to make a two-inch cube. Observe the cube as it looks, with a face toward you and on the line of the eye. How many faces do you see?



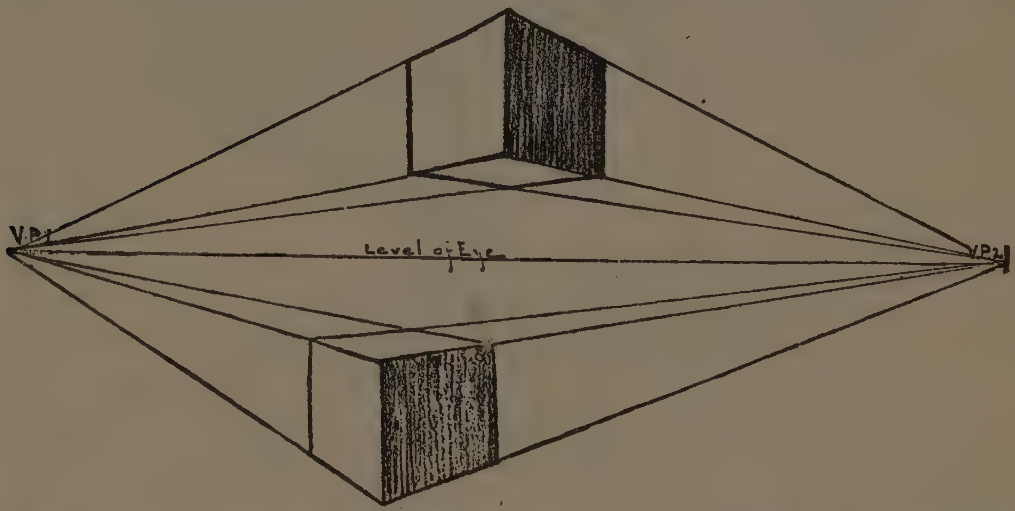
CUBES IN PERSPECTIVE

(Answer: One face.) Draw what you see. Keeping the face towards you, hold the cube a little below the line of the eye. What face comes into view? (Answer: The top face.) How does it look? (Answer: Foreshortened.) How wide does it look? Lower it and notice the change. Notice the converging lines of the receding edges. Draw the cube in this position.

Hold the cube a little above the line of the eye. What face comes into view? (Answer: The bottom face.) How does it look? (Answer: Foreshortened.) Draw it as it appears. Draw on 9 x 12 paper a long horizontal line to represent the eye level. Draw the appearance of the cube as it looks when the top edge is on the level of the eye; when a little below the level of the eye, and when a little above the eye level. Note the extended lines which come to a point on the level of the eye. See the illustration.

After the foregoing is quite clear to the children, try placing the cube turned with one edge toward you and the sides turned equally away. Hold it by the back corner, and observe how it looks when a little below the level of the eye, and also a little above the eye level. The top face and the bottom face in these positions resemble what figure? (Answer: A diamond shape.) Notice the slant of the side lines. There will be a group of parallel lines that will converge to a vanishing point at the left, another set at the right, the vanishing point being on the line of the eye. Illustrate this by drawing these two sets of converging lines on the blackboard, showing the two vanishing points.

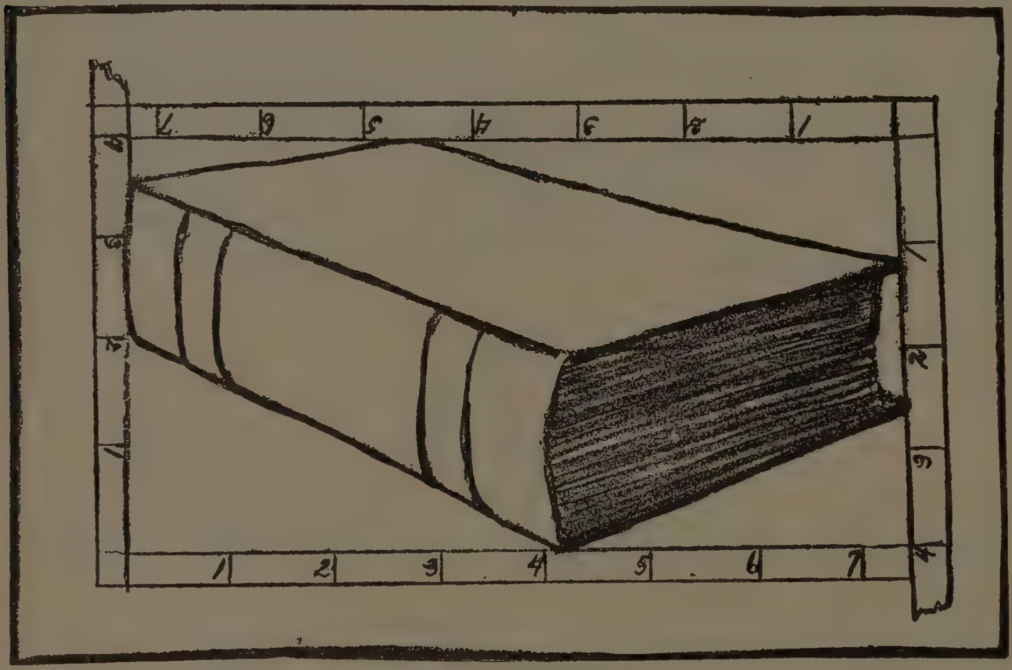
Teach the children how to measure the foreshortened faces by measuring with the ruler from the front edge out straight to the left and right, not on the slant. The two faces will appear equally foreshortened. We saw the cube turned at an angle of 45°.



CUBE ABOVE LEVEL OF THE EYE, DRAWN AT AN ANGLE OF 45 DEGREES
CUBE BELOW LEVEL OF THE EYE, DRAWN AT AN ANGLE OF 45 DEGREES

At the next lesson develop the problem when the cube is turned so that one side appears smaller than the other. Place the cube on the back of the desk. Draw the vertical edge which is nearest and shows the actual height. Measure with the ruler, touching the front edge, to find how far to the right and left the farther edges must be drawn. Place the ruler flat on the desk, just touching the front vertical edge, and notice the angle made between it and the lower receding edges. The more foreshortened face will be drawn at a greater angle from the horizontal line which indicates the position of the ruler than the less foreshortened face.

After these base lines have been drawn correctly and the width of the faces indicated, the other lines must be drawn slightly converging with these base lines, making the farther vertical edges a little shorter than the front vertical edge. Notice the position of the farther corner and the shape of the top face. Sketch lightly with tentative lines, until the drawing looks right.

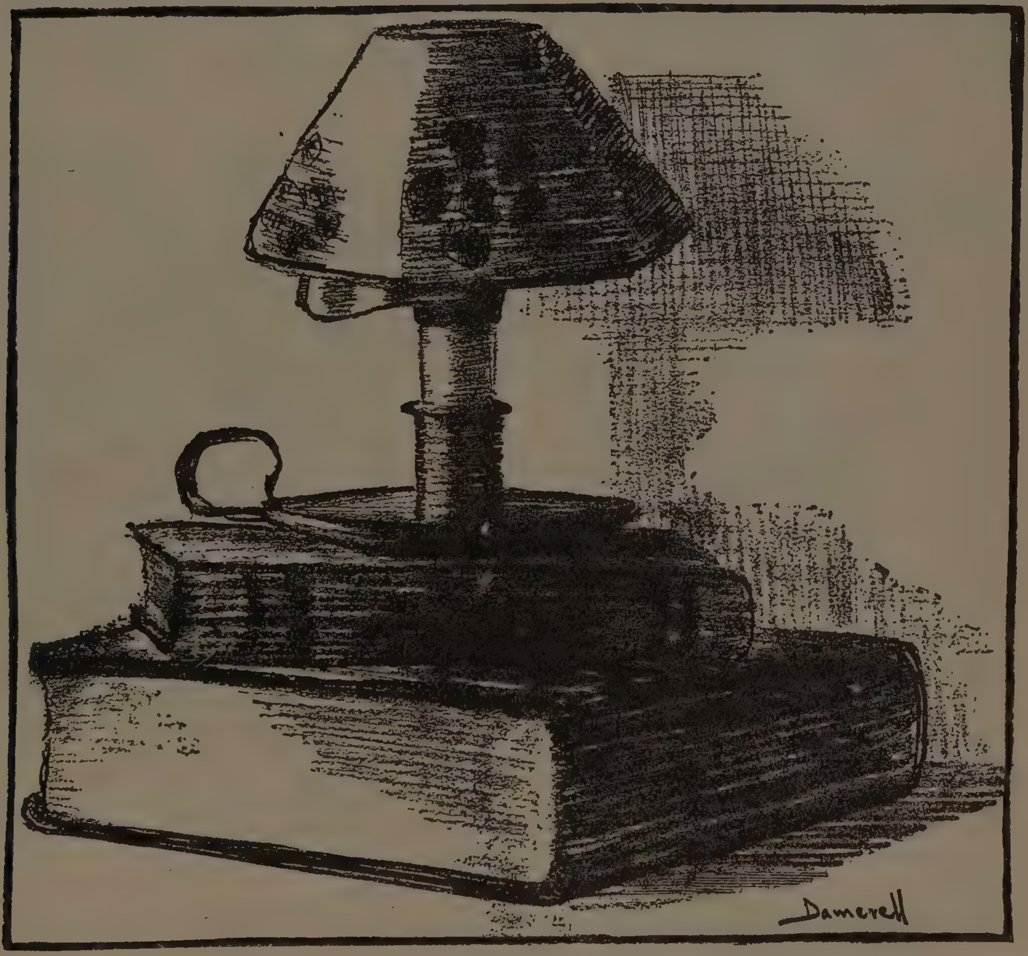


BOOK DRAWN WITH THE AID OF FINDERS

Make several experiments with the cube placed in different positions, and draw what you see. After studying it turned at an angle below the line of the eye, look at it a little above the eye level, and draw again.

42. Third Week. Rectangular Objects (Continued). (1) *Cube* (Continued). It will take some time for the pupils to gain a working knowledge of the principles of perspective; to help them to visualize the appearance of the cube placed at any angle, the teacher may suggest the different positions by partly sketching the cube on the board, and asking the pupils to hold their cubes in the position indicated by the lines drawn. Ask them to finish the sketch by observing how the other lines should be drawn. Practice on this until the pupils can draw the cube in any position. Heavy lines indicate the lines to be drawn on the board. See illustration.

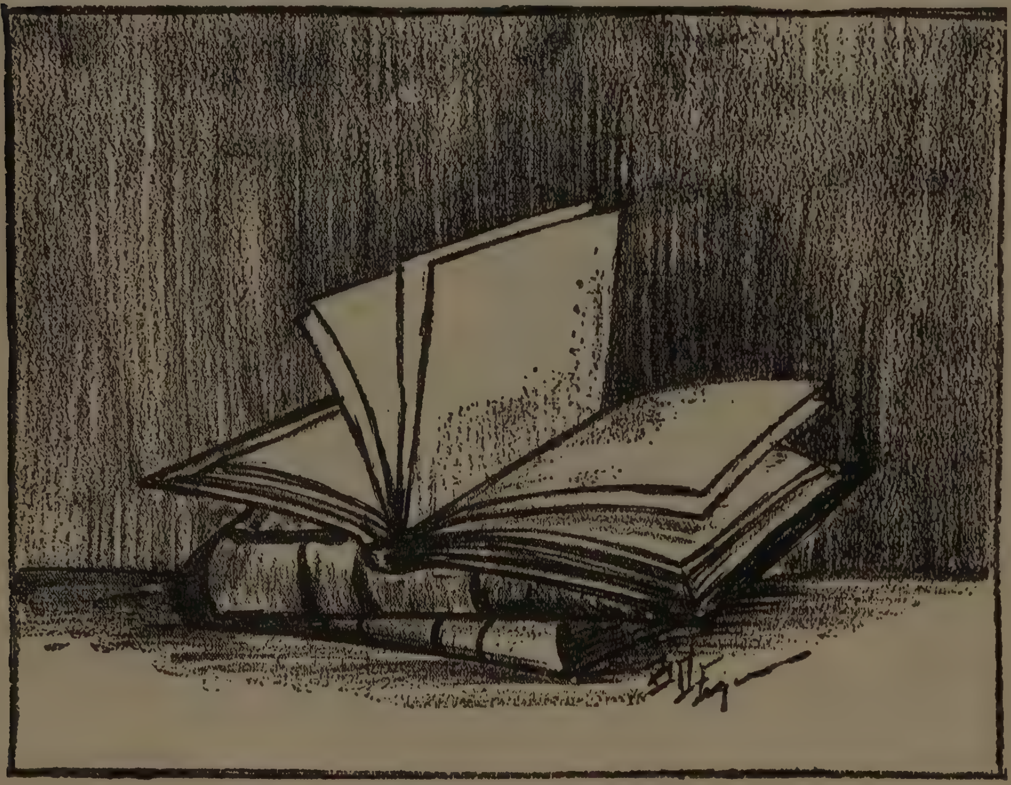
(2) *House.* In the next lesson apply these principles by drawing a house in perspective. The teacher should draw a sketch of the house on the blackboard, commencing with the vertical corner nearest to the observer. Then indicate the farther corners, showing the amount of foreshortening



GROUP OF RECTANGULAR OBJECTS IN PERSPECTIVE observed in the sides of the house, and the length of the corners compared with the first corner drawn. Place the gable by finding the center, shown by drawing diagonal lines at the end and erecting a vertical line. Remember the lines at the eaves and roof will slant downward a little, while the lines at the ground will slant slightly up toward the horizon, or level of the eye.

The birthplace of George Washington would be an appropriate sketch to make this week; also the old log cabin which is so familiar to us as the birthplace of Lincoln.

43. Fourth Week. (a) RECTANGULAR OBJECTS (CONTINUED). Continue drawing rectangular objects, including boxes, books, tables and other common objects. Use pencils or colored crayons.



BOOKS IN PERSPECTIVE

Place the objects to be studied on boards between the desks, and call the pupils' attention to their position. Are the objects seen in parallel or in angular perspective? Hold the ruler out and notice the angles made by the receding edges of the object with the ruler, as it appears to touch the lower edge of the object. Finders made of a piece of cardboard, or paper, and shaped like a carpenter's square, may be held to show the exact angle made by any receding line. Hold one arm of the finder vertical, and let the other follow the base lines of the object.

Try drawing a single book in different positions; then try a group of books, a candlestick or a piece of pottery. See the illustration of books.

If the view from the schoolroom window gives an opportunity to try sketching houses, a part of the week might be taken up in so doing, or the teacher may sketch a winter landscape on the blackboard, and the pupils may make sketches from this.

(b) Review. Review and reiterate the principles learned this month in observing the appearance of rectangular objects. Give the pupils the following principles and ask them to write and learn them:

CHAIR IN PERSPECTIVE

(1) The apparent width from front to back of any horizontal face decreases as it approaches the level of the eye.

(2) The farther of two edges horizontal from left to right appears shorter than the nearer.

(3) All parallel horizontal edges receding from the eye appear to converge.

(4) All receding horizontal edges appear to incline toward the level of the eye, and must be drawn so that, if produced, they will meet in a point on the level of the eye.

This month's work deals with some prosaic facts in object drawing, but upon these truths more interesting work will be developed. It has been well observed that "Nobody really knows about any subject until its length, breadth and height are equal in clearness in his mind." This is particularly true of the subject of perspective.

Test. Make a drawing of the chalk box facing below the level of the eye. Make a drawing of this box turned at an angle, below the level of the eye. Make a drawing of a group of two books in angular perspective.

Write the principles involved in drawing objects in parallel and angular perspective.

MARCH

We love best when we see them painted
Things we have passed a hundred times
Nor cared to see,
And so they are better painted,
Better for you and me.

—*Browning.*

44. First Week. REPRESENTATION. During January and February the pupils have been learning something of the alphabet of form and the principles governing its representation. Let them continue their drawing of objects for a few weeks in order that they may express in terms of beauty some of the common forms about them.

You have studied the single object with considerable care. Now consider the grouping of objects, placing two or more together in a way that they may illustrate a thought—in other words, tell a story.

(1) *Grouping.* In making a group, determine first the idea to be expressed, thus leading to the selection of objects having harmonious relations, that is, objects that seem to

belong together. For example, objects to be found in the kitchen can be placed together, but objects from the kitchen are not to be grouped with parlor bric-a-brac.

(2) *Composition.* One of the most important elements in representation is that of composition. This element enters into all representation, whether of single objects or a group of objects. In the single object it is a question of proper placing, or composing, in the space on the paper upon which it is to be represented. In grouping, the first thought is to have the objects well arranged or composed so as to make a pleasing whole. Unity is the great law of good arrangement or composition. Ruskin defines composition as "the help of everything in the picture by everything else.

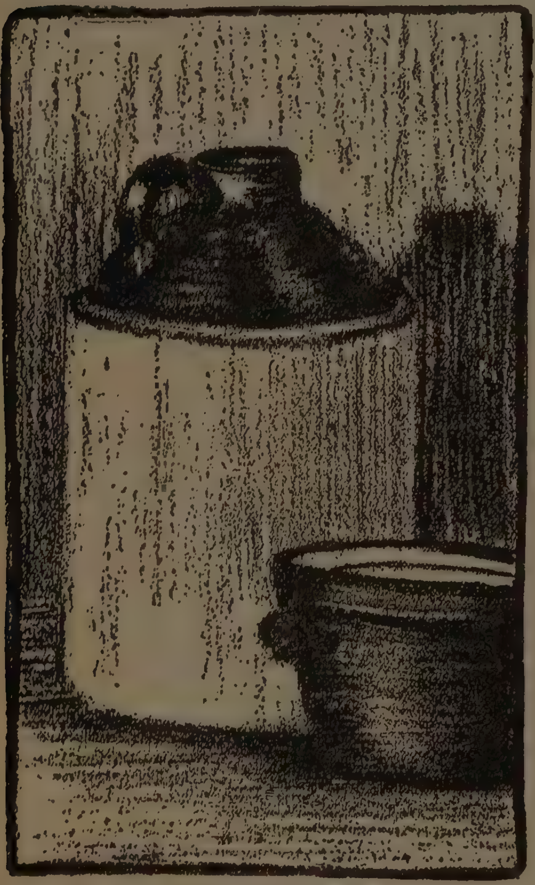
(3) *Arrangement of a Group.* Learn the essentials of good arrangement by placing objects together. Have for use in the lesson several pieces of pottery used in previous lessons, and some vegetables—potatoes, onions or squashes. Think of the objects that would be associated together in preparing these vegetables. Choose a pot, a pan or a basket for the potatoes or onions, and arrange them together as they might look on the kitchen table.

Place the potatoes with an object by themselves, the onions with another; then place them beside the pan, but not directly in front of it, thereby concealing the whole base of the pan.

Place one vegetable a little behind another. This gives us a variety. Compare this arrangement with that obtained by placing the objects in a row, or at random. If the squash is used, a larger object would be most suitable to place with it. A jug placed beside the squash, or partly back of it, would suggest a cellar group.

Try representing a group arranged on boards between the aisles, using pencil and manila or white drawing paper. Sketch in light, blocking-in lines, and be careful to place the object which is nearest you in a lower portion on the paper than the object farther away. Then compare the light and shade sides of the objects, and show the shading on the vegetables with slanting strokes. See illustrations, including Color Plate Five.

Try grouping two pottery forms together, choosing those that are varied in form and have interesting color contrasts. For instance, a tall jar with a shorter one; a dark jug with a light one; a pitcher and cup or bowl placed together; a teapot with cup and saucer, jug, bowl, etc. Select objects of interest around the schoolhouse; for instance, the coal pail, some sticks of wood, fire tongs, poker, and the water pail and dipper make interesting studies.



STUDY IN GROUPING

In a good group, the principal object is placed near the center. The secondary objects should be arranged so that their bases will not be in a straight line, or in a direct line with the base of the principal object. Arrange them so that a partial view of some object is seen, and try to have a variety in position; but make the objects seem to belong together and to be at rest. Do not leave too great a space between them. A good group gives one a feeling of repose and harmony, and if boundary lines were drawn about it, they would form an irregular figure, usually a triangle.

45. Second Week. REPRESENTATION (CONTINUED). Last week cylindrical objects were used in grouping; try rectangular objects this week. Use the material available in the schoolroom, such as chalk boxes and books. Various sizes of books can be used to give variety to the groups.

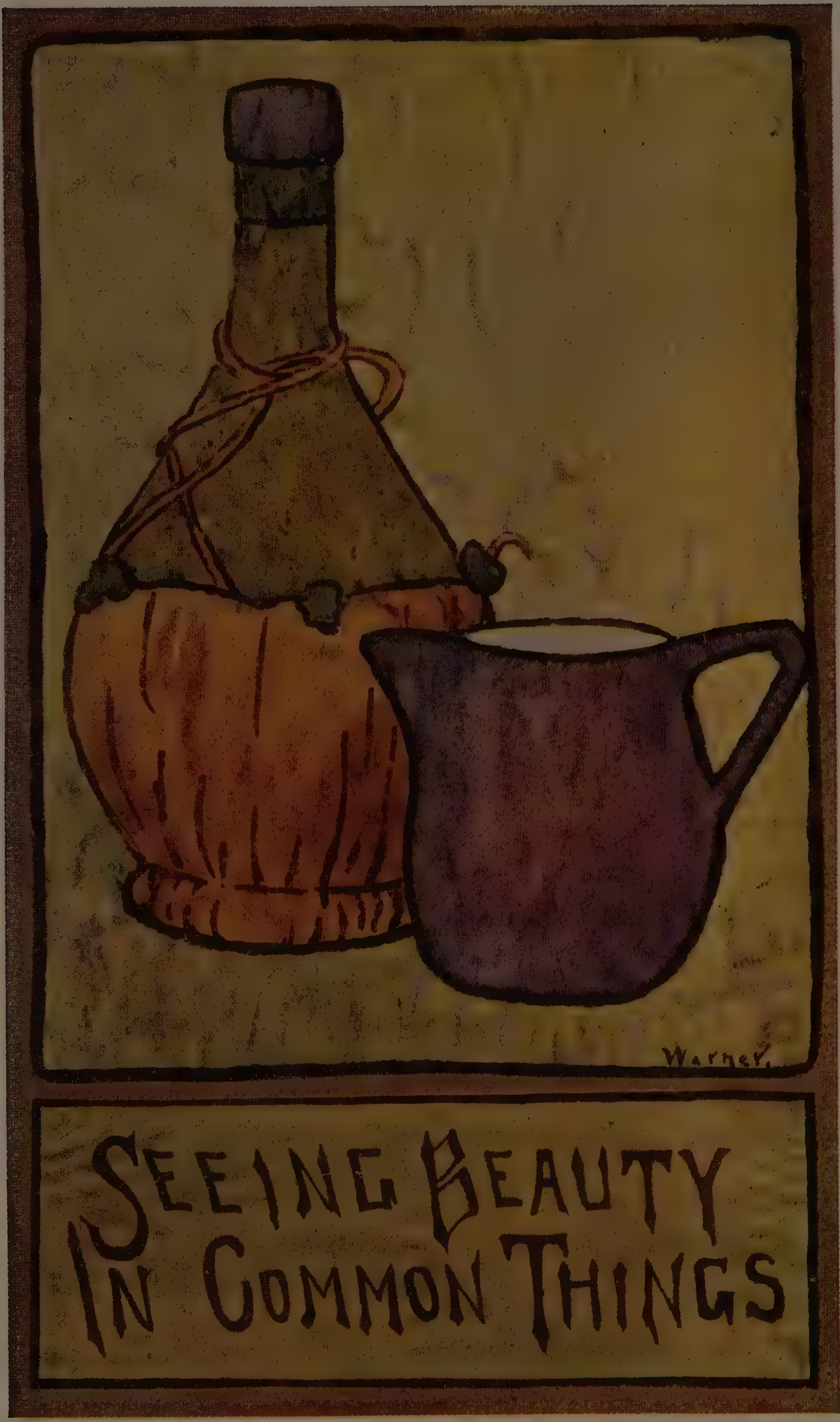
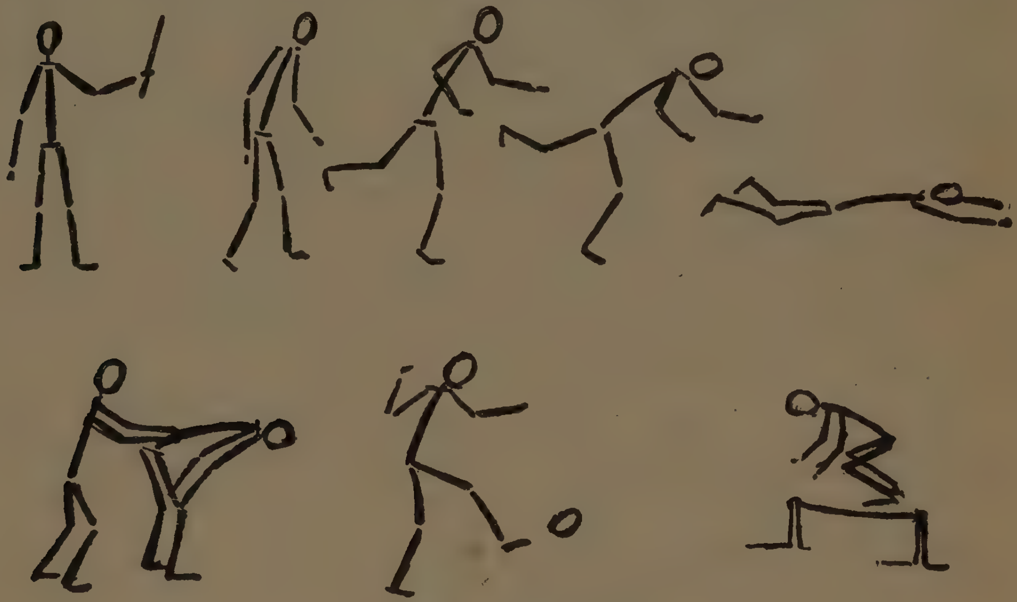


Plate Five

What can you place with a chalk box to make an interesting group? Something appropriate would be two or three pieces of chalk and an eraser. Arrange them to make a pleasing group. Draw in outline and complete in light and shade. If a group of books is chosen, two or three arranged carelessly together will afford an excellent problem in perspective.

To assist the children to see the appearance of receding edges, direct them to cut out two right angles from a piece of cardboard or stiff paper. By holding these in front of a group, the amount of slant is quickly seen. The pupils will receive considerable assistance in getting a correct idea of the foreshortened faces of the top of the books by sticking pins vertically in their faces near the corners, then comparing the placing of the distant corners and edges with the height of these pins.



POSES IN OUTLINE

Another method of determining the foreshortening is to measure with the ruler held upright, allowing the top of the ruler to touch the highest point in the group, and the thumb to slide down to show the lowest point, then compare that measurement with the whole length of the group. Of course, these measurements must be made with the same existing proportions in your study. For instance, if the books appear three inches high and five inches long, then these measurements, or those bearing the same ratio, must be used in the drawing. We may enlarge the drawing, or reduce it, by multiplying or dividing the original measurement by the same number.

The dictionary and teacher's bell will make an interesting group, and a dinner box with a cup will make another. Other groups of interest would be a candlestick with books and the globe with books.

46. Third Week. THE HUMAN FIGURE. In some schools where a thorough course in drawing in the primary grades has laid the foundation upon which to build, the work in object drawing might be continued, and advanced problems like a corner of the school room, an open door, a chair or the teacher's desk could well be studied during the remainder of the month. See illustrations. But if the children have not had much previous work, it will not be well to continue object drawing to the exclusion of many interesting exercises which may be included in the spring work.

Though March is such a variable month, before this time there will be some signs of the awakening of new life—the return of a few birds, the swelling buds and the exuberant activity of the children, who will be anxious to try the spring games of marbles, flying kites, jumping rope, playing ball, and other pastimes. Utilize these natural activities in connection with a study of the human figure. It will be well to review the simple action lines, or skeleton figures, preliminary to working from the figure.

Choose one of the smaller boys to pose, and ask him to stand on a chair, or table, where all can see him. Observe the upright figure. Can you draw one line to express this position? (*Answer:* A vertical line.) Compare this with a prostrate figure, which may be shown with a horizontal line. Now compare parts of the figure, trunk, limbs and head. By measurement you will discover the relative proportion of the parts of the body, the trunk and head forming the upper half, and the lower limbs the lower half of the figure.

Draw a small circle for the head and straight lines to express the trunk and limbs, leaving a small open space at the knees and elbows.

Ask a boy to walk across the floor, then to run; observe the change in direction of trunk and limbs.

Try representing the figure in action, using straight lines. After representing the skeleton figures, showing walking and running, illustrate jumping, pulling and pushing poses, until the pupils can show quickly, with a few lines, the action of the figure. See the illustration, page 443.

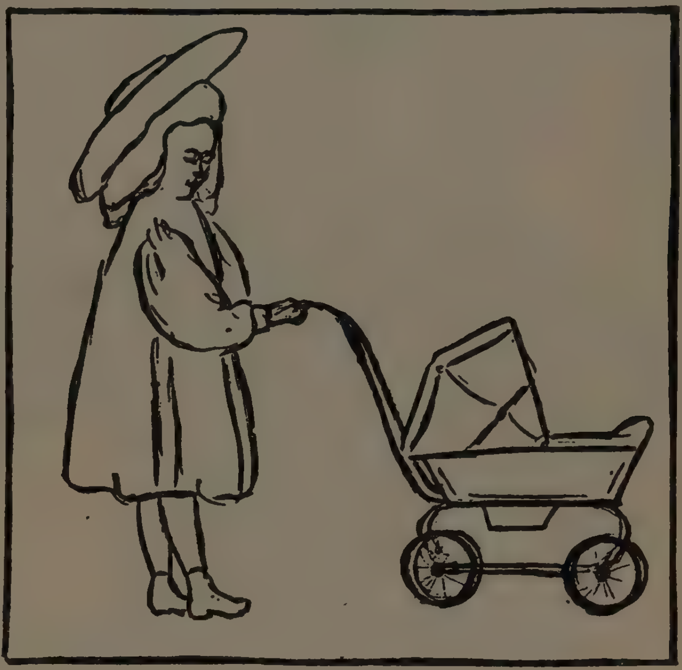


FIGURE POSING

Follow these exercises with a study of the figure in mass, making a silhouette in ink or black water color, which will show the shape of the figure. See the illustration.

Let the boy take some position for decided action, as the position of a boy with a bat, or stooping to catch a ball, or aiming with a gun (using a pointer for a gun). Form a group by having two boys pose for playing leap-frog.

Use brush and ink to show the direction the trunk and limbs take, then fill in, working from the center to the outer edge to get the shape of the figure. Show the position of the head, body and limbs in simple mass effect. See the illustrations.

47. Fourth Week. Figure Work (Continued). After showing the figure in mass effect, try expressing the pose in

STUDY IN CHARCOAL

pencil outline, which is a little more difficult, but also more explicit.

Vary the work by allowing one of the girls to pose; if she wears a hat and coat and carries an umbrella it will make an interesting pose. Use blocking in lines as before, and place the center of the figure, waist line, etc. Sketch in light, loose, tentative lines at first, getting the relative placing of the parts before making firm lines for the finished sketch.

If possible, use some idea developed in reading to suggest interesting poses. A Puritan figure can be quickly shown by using white paper cap, collar and cuffs, with a white apron. If the figure is represented as reading, we have a very good Priscilla. Try to show the dark parts of the dress by pencil painting, leaving the white parts the color of the paper.

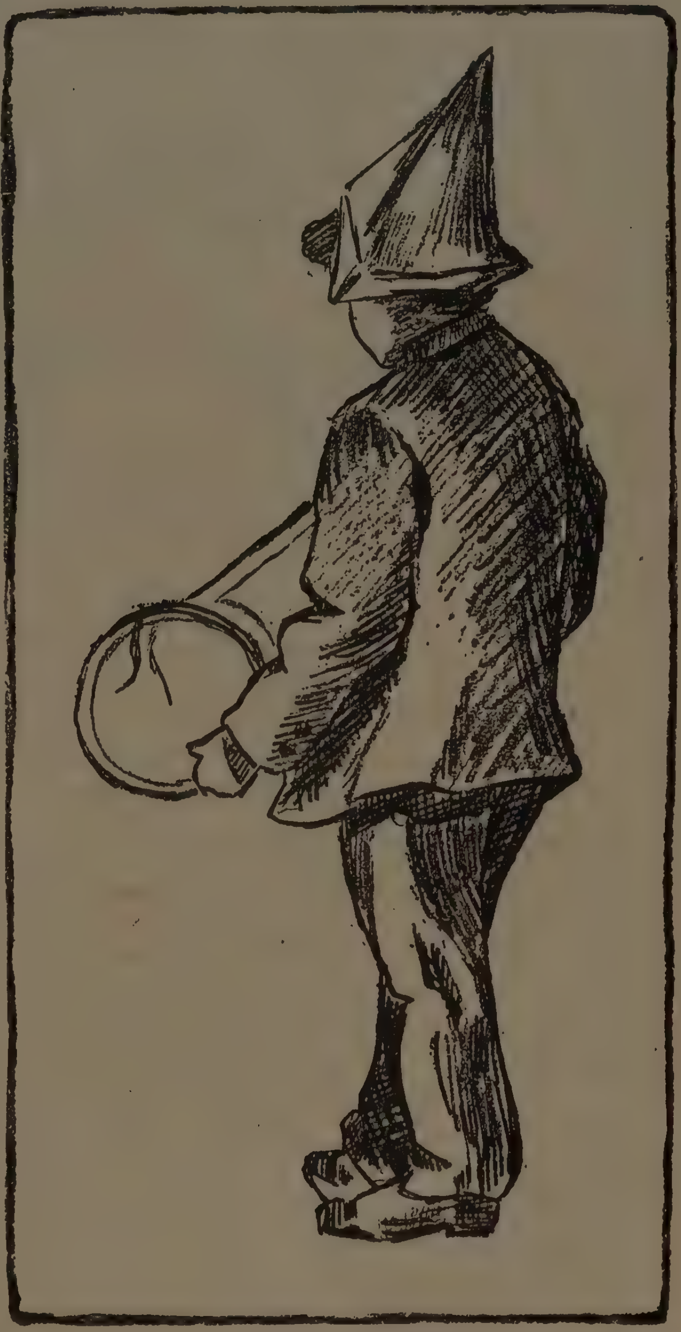


FIGURE POSING

The children will soon become interested in making each other's pictures, and often some real talent in figure drawing will be discovered. See the illustrations.

In connection with the study of the figure, try to show the children some of the great masters' work in figure painting. Jean Francois Millet, the French peasant painter, has shown us how simply treated some of the great themes of farm life may be. *The Sower*, *The Peasant*, *Grafting a Tree*, *The Shepherdess*, *Knitting*, *Bringing Home the New Born Calf*, and others, make us feel the simplicity and poetry of the life around us.

Test. Make a drawing of a group of objects found in the schoolroom illustrating both cylindrical and rectangular perspective.

Name three essentials in good grouping.

Make a drawing of a child posing, illustrating some game, such as playing ball or marbles.

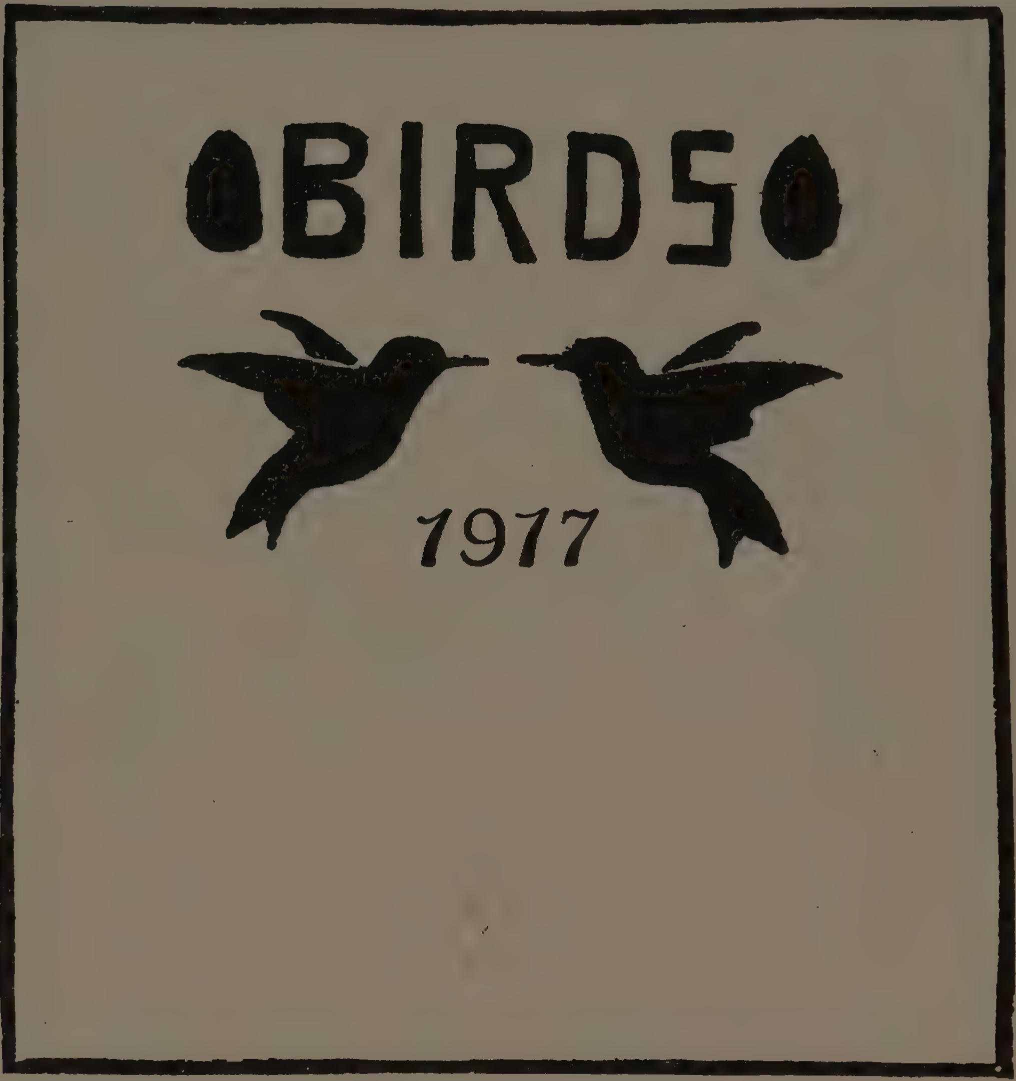
APRIL

Come children, dance and sing
For spring is here.
The crust of earth is breaking,
The flowers are all awaking.
Come, dance and sing.

48. First Week. BIRD STUDY. To enumerate the joys of life in the spring is to suggest abundant material for art study. The return of the birds, the new growth of the buds, the first flowers, the spring landscape, the animal life, spring gardening, are all fruitful sources for observation and expression.

Have you kept a record of the return of the birds this past month? What birds arrived first? Have you seen the robin, the blue jay, the blue bird and the flicker? Do you have the bird pictures in the schoolroom? Outline bird studies for children to color, published by the Davis Press, Worcester, Mass., are helpful.

From bird pictures and observations from nature, try painting or drawing pictures of the birds named above. The color adds great interest, and if water color is used, paint the body of the bird egg-shaped, then add the head, tail and wings. If a written record of observations is kept, a cover for the bird booklet would be a good problem. Try using the bird motif in a decorative way for the booklet cover, making a symmetrical unit instead of a mere picture of a bird. See the illustration.



COVER FOR BIRD BOOK

49. Second Week. Animal Studies. Besides the birds, the rabbit and chickens make interesting studies at this time. Ask the children to bring some of their pets to school, and after a few lessons from the animals indoors, encourage the children to sketch from the animals at home.

(1) *The Rabbit.* The rabbit makes one of the best subjects in animal study, because it is so gentle. It may be brought to school in a basket and placed on the table for study during the lesson period; or, better still, have a box in which it may be kept and allowed to remain several days. The easiest way to express the animal form is by the use of ink and brush. Make a silhouette to show the shape of the body, head and other prominent parts. Second, try sketching in outline with a pencil. Third, show spotting by pencil painting.

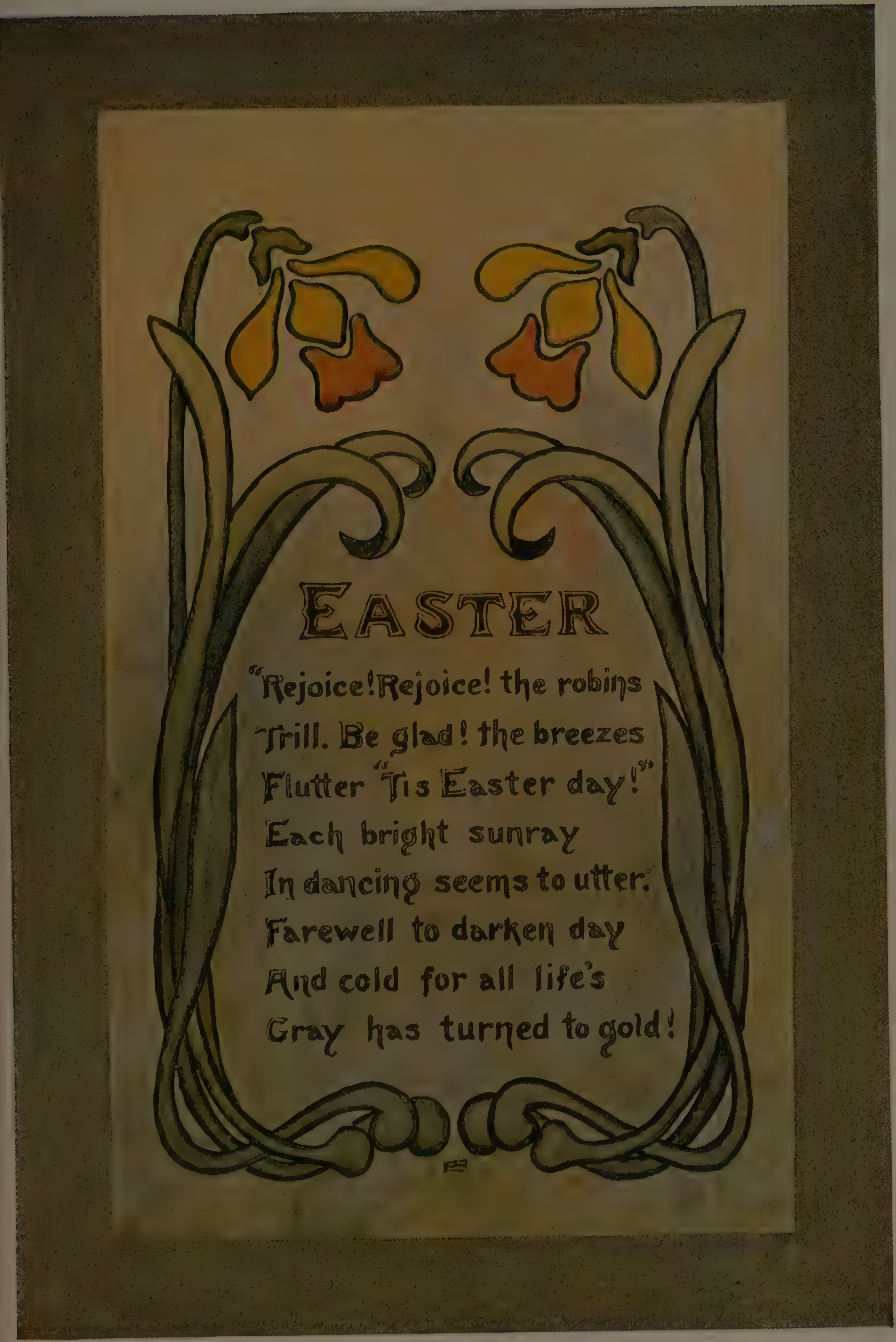
ANIMAL STUDY

The proportion of the body, and the relative size of the head to the body, should be carefully studied, and blocking-in lines should be used to express these proportions.

The rabbit makes an excellent subject for a lesson in clay modeling. Soften the clay by soaking in water, then placing it in a cloth bag, and working it to the consistency of putty. First, make a ball-shaped body, then the head and ears, and press them into position. Shape all the parts from the one piece of clay, instead of making the details in separate pieces and putting them on. Allow the clay models to be dried, and then, when desired, they may be soaked up again for another lesson in clay modeling.

(2) *The Chicken.* A rooster or a pet hen makes a fine subject for a lesson. It may be wise to have the bird in a cage, unless it is very tame. Use the same process as outlined before. Make a mass painting first with brush and ink, getting a silhouette; then try with pencils or crayon.

50. Third Week. ANIMAL STUDY (CONTINUED). Ask the children to bring other pets to school—a gentle dog or cat; in the country even a lamb might be attempted. If the animal moves frequently, try making snap shots, as it were,



EASTER

"Rejoice!Rejoice! the robins
Trill. Be glad! the breezes
Flutter "Tis Easter day!"
Each bright sunray
In dancing seems to utter:
Farewell to darken day
And cold for all life's
Gray has turned to gold!

Plate Six EASTER GREETINGS

working from memory. Silhouette work and outline drawing in pencil will be the best methods to employ.

51. Fourth Week. (a) Easter Decorations. Choose something appropriate for an Easter sentiment, and plan to print it carefully. In the upper grades an appropriate decoration can be added, using a conventionalized flower. The Easter lily, crocus, spring anemone or the daffodil will be most suitable. Print a simple, straight-line alphabet on the board, and after the children have chosen their text, let them plan with rulers the space for the letters. They should place lines at the top and bottom of each row of letters, divide the long space into small spaces for each letter, then place each letter in its space, leaving a small space between the letters and longer spaces between the words.

The Alder by the river
Shakes out its powdery curls
The Willow buds in silver
For little boys and girls."

Here are some appropriate texts:

May Joy be Yours,
This Easter-tide.

O the glory of the spring-
time
Making all things bright
and new!
O the rosy eve's surrender
To the Easter moonlight tender.
—*Havergal.*

Within, above, and all
around
The chimes of deep cathedral bells
An early herald peal
that tells
A glorious Easter-tide
begun.
—*Havergal.*

In planning a decoration for the sentiment, plan a border space, dividing it also into spaces. With paper and scissors, make a little flower shape that will fill the small space. Place this pattern in each square space into which the border is divided, and trace around it. Paint the border in appropriate color, to suggest spring; green and white, purple and green, or pink and green are suitable colors. Outline the design in black, using a fine brush and ink or black water color. See Color Plate Six.

This week's work may be taken at the time most suggestive of the Easter day. More elaborate designs for Easter thought may be worked out if the children have had some previous work in designing. If preferred, an appropriate text simply bearing on spring may be chosen instead of the special Easter thought.

(b) MEMORY DRAWINGS. Memory drawing should be encouraged frequently in other lines of work, instead of always depending on the object; then the mind would be accustomed to retaining the image, and greater working power would be the result.

Test. Make a drawing from two tree branches having buds. Use a pencil. Make a cover for a nature booklet. Print the words, "Nature Booklet," and make a border, using bird or flower motif. (Use ink or black water color.)

MAY

Robins in the tree top,
Blossoms in the grass,
Green things a-growing
Everywhere you pass.
Sudden little breezes,
Showers of silver dew,
Black bough and bent twig
Budding out anew.
Pine tree and willow tree
Tinged elm and larch,
Don't you think that May-time's
Pleasanter than March?

—*Thomas Bailey Aldrich.*

52. First Week. SPRING FLOWERS. Do you know the spring flowers as they appear? The trailing arbutus in the northern woods, the pussy willows, now to catkins grown, the hepatica, the anemone, the spring beauty, the wake-robin, Jack-in-the-pulpit, dogwood blossoms, violets and buttercups in the woods and fields, and in our gardens the tulips, iris and firebush all make delightful studies. Besides the birds, buds and trees, the brooks are teeming with wonderful lessons of

MAGNOLIA

Plate Seven TULIPS

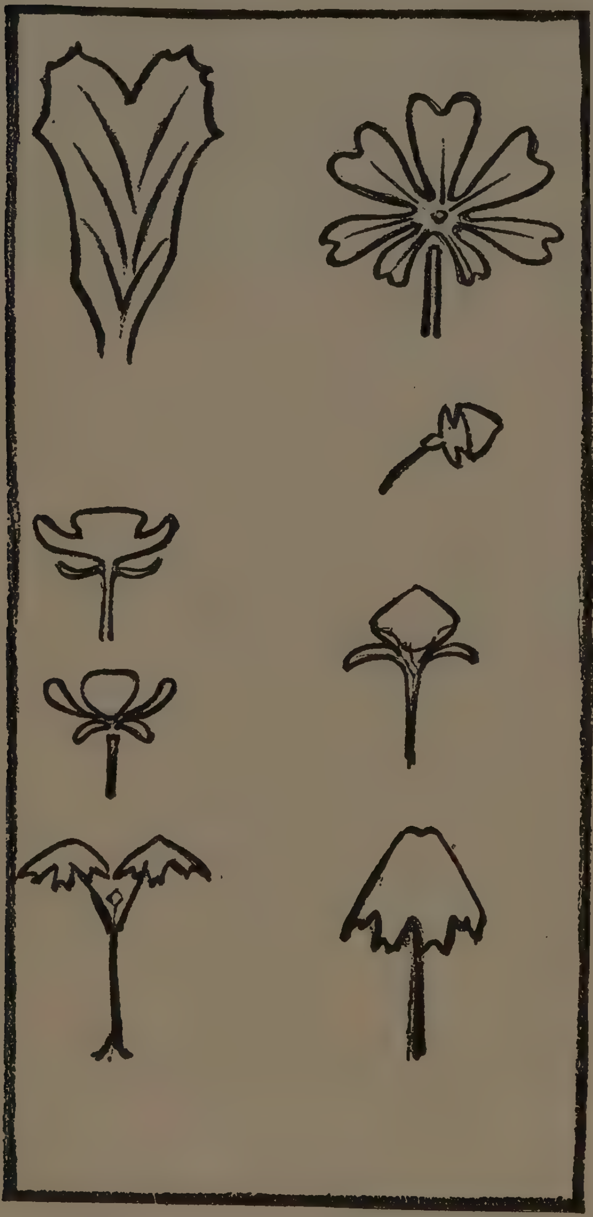
life. The water bugs, fishes, frogs and frog's eggs and tadpoles and a stray tortoise can be collected to make a school aquarium. All of this material will serve in its turn not alone as interesting material for nature study but for art subjects, as well.

DESIGN FROM MANDRAKE

Choose the large, single flowers, like dogwood blossoms, tulips, Jack-in-the-pulpit and magnolia, rather than the small, intricate flowers, like the violet, the anemone and the hepatica.

Fasten the study chosen to a cardboard easel, and place this on boards between the front desks. Study the plan of growth, the arrangement of leaves, whether alternate or opposite, the position of the flower, whether at the end of the stem or in the axil of the leaf. Observe carefully the amount of foreshortening in the flower and leaf, and show by light, blocking-in lines the direction of the stem and the position of the various parts. Represent the color effect by pencil painting. See the illustration.

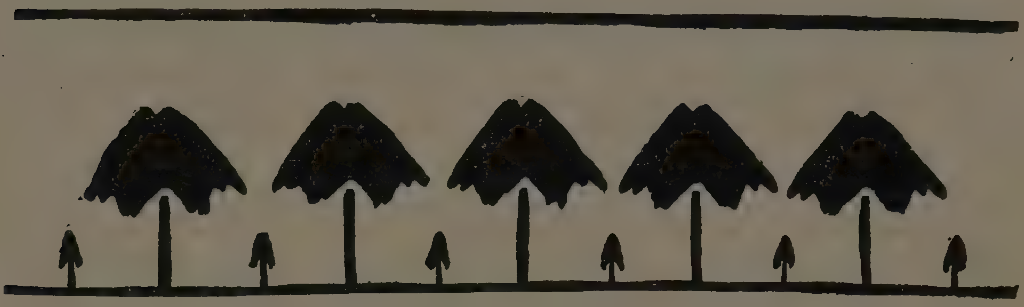
53. Second Week. FLOWERS OR TREE BUDS IN COLOR. The same flowers used last week may be chosen, or others may be selected. Use water colors and manila paper, if flowers are chosen, and colored crayons, if tree buds are studied.



DESIGN UNITS FROM MANDRAKE

Study the color and form of the subject, and practice mixing colors to match the flowers and leaves, if water color is the medium. Have the pupils practice on paper, to gain freedom in handling the brush and color. Express slender stems by holding the brush upright. Press on the brush to obtain breadth of stroke for the leaves. Work in mass effect; do not outline the flower and leaves and then fill in, but work from the center out. Commence with the part of the study, flowers or leaves that you find at the top, and work down to the bottom, expressing leaves and stems as you come to them. See Color Plates Seven and Eight.

Try several flower studies in this way, or vary the week's work by using tree buds expressed in water color or colored crayon. The waxy horse chestnut, the popular catkins and others may be used as soon as they appear. Let these lessons be given when the nature material is in season.



BORDER DESIGN FROM MANDRAKE

54. Third Week. Spring Booklet. The last two weeks can be very profitably devoted to written exercises pertaining to spring. The nature walks and talks will make very profitable material for subject matter for writing lessons, and the art work will illustrate these very acceptably. Plan to make a cover for the booklet of exercises, and use some appropriate nature unit, either insect or flower, for the design. If the flowers are used, select one which is simple, like the marsh marigold, trillium or Jack-in-the-pulpit.

Analyze the flower to see the underlying plan and the number and shape of the petals. Draw the top and side view of the flower in outline. The top view will give a radial arrangement, called a rosette, while the side view gives a bisymmetric unit, based on a center line.

Plan the units to make a border or a surface pattern, leaving space for the printing of the name and date. After the outline of the design is drawn, paint the same in water colors or ink, or use colored crayons. See the illustration.

SPRING LANDSCAPE

Plan the printing carefully, drawing lines with the ruler at the top and bottom of the letters, and then spacing off the letters, making them with straight lines. Paint with ink, or water color which will harmonize with the design. The paper used in this exercise may be manila, but the colored papers, or bogus paper, are to be preferred. Fasten the papers in the cover with a cord.

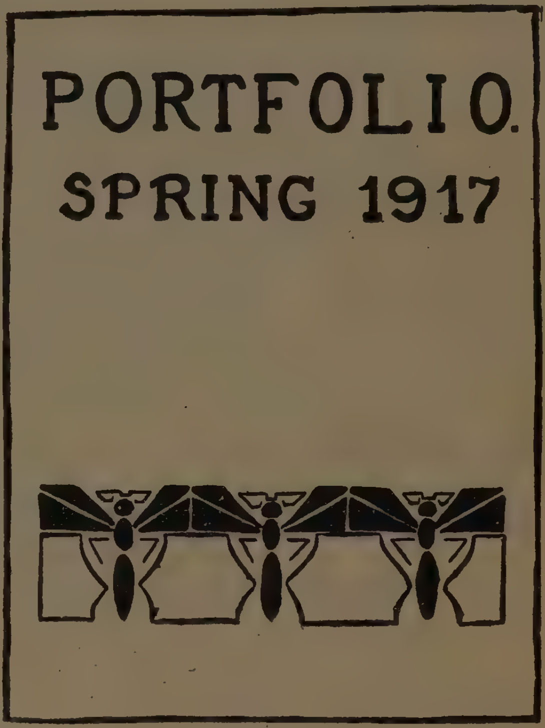
55. Fourth Week. SPRING LANDSCAPES. To aid the children in choosing good subjects for landscape study, draw a long stretch of horizon, including several trees, perhaps a house or two, on the blackboard, and show the children how to use a finder by folding or cutting two right angles of paper and holding them to make a little frame, through which they may choose a small section of the landscape

Plate Eight MAGNOLIA BLOSSOMS

drawn. See illustration, page 461. Draw the part selected on manila paper, and show by pencil painting the color of the trees and the ground. Follow this lesson in copying from the blackboard by a sketch from out-of-doors, either window observations or a memory sketch.

The Bartholomew and the Woodbury *Pencil Sketches from Nature* make very helpful studies for the children to copy at this time. They are inexpensive (25 cents per set of six), and can be obtained of the Prang Company, Chicago.

Test. (a) Draw in outline a spring plant—a tulip or other large flower. (b) Make a painting from a flower study, using water colors or ink

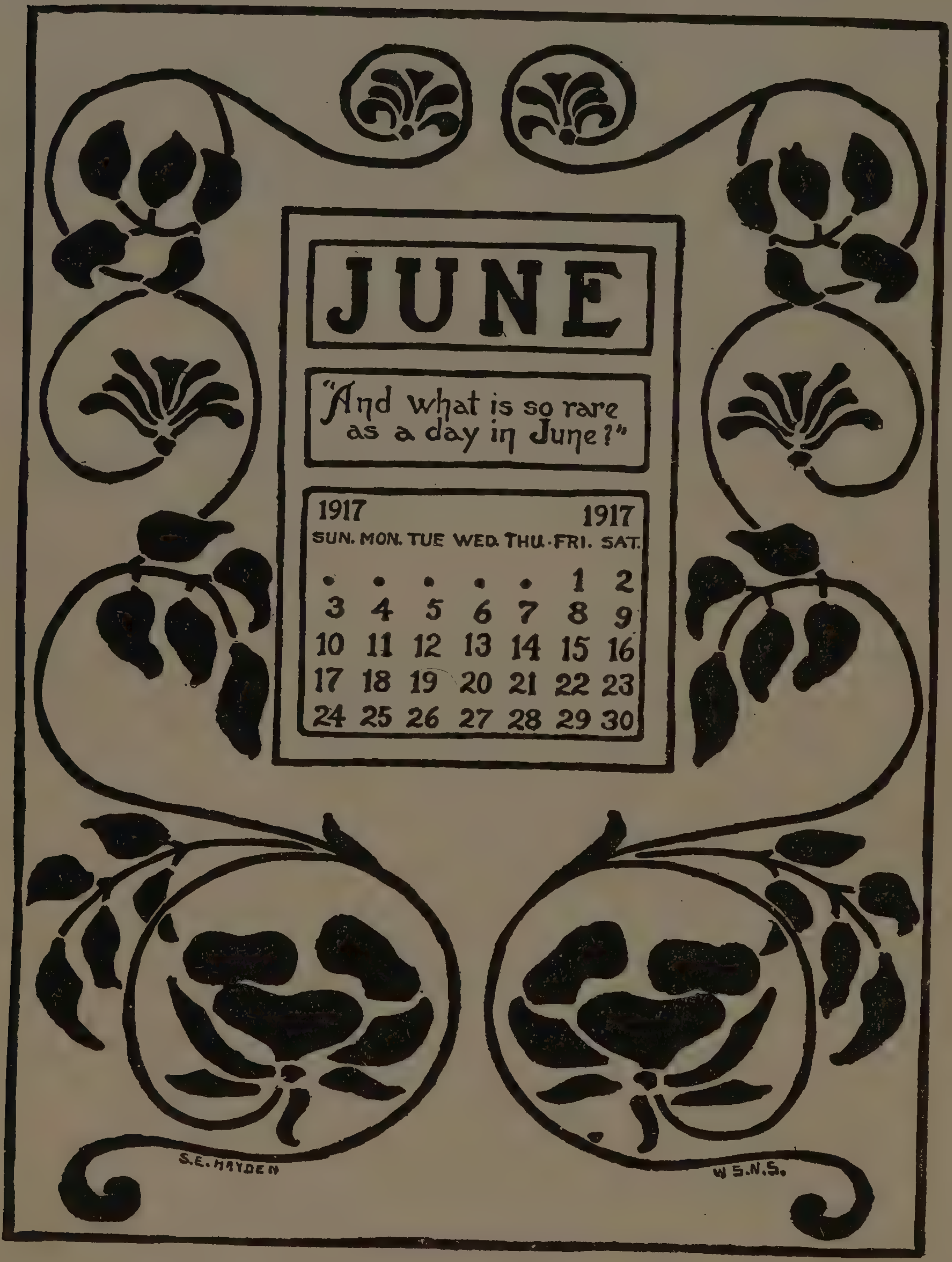


JUNE

Look without!
  Behold the beauty of the day; the shout
Of color to glad color, rocks and trees
And sun and sea, and wind and sky!
    All these
Are God's expression, art work of his hand
Which men must love, ere they can understand.
—*Richard Hovey.*

56. First Week. Spring Landscapes (Continued). The children have attempted to represent the landscape in pencil painting during the last week. Let them try this week to express the beauty of color in sky and tree and ground—possibly a stream, or pond, which will reflect the glory of the sky.

Paint in the color of the sky, after putting a water wash over the paper, and then paint the green for meadow or lawn.



JUNE

"And what is so rare as a day in June?"

1917 1917

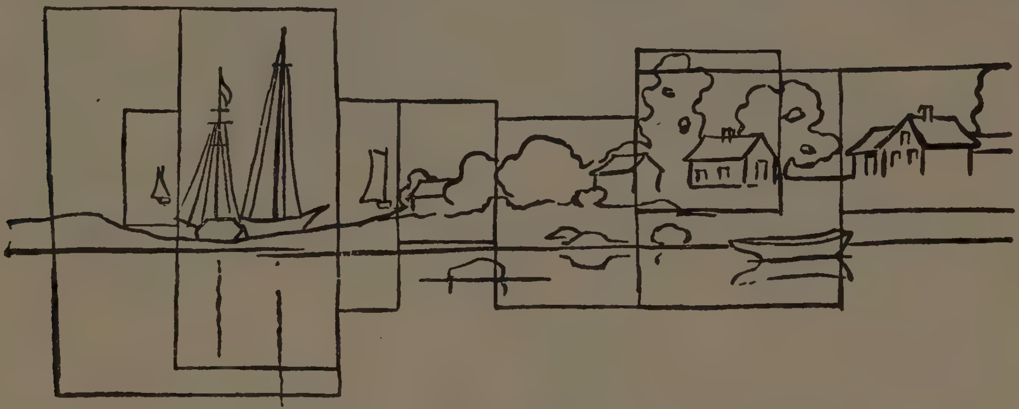
SUN.	MON.	TUE	WED.	THU.	FRI.	SAT.
•	•	•	•	•	1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30

After practicing the shape of the trees on a dry piece of paper, paint the trees in mass to suggest the particular trees they may be studying. Possibly the peach or apple trees in bloom are chosen; if so, paint the delicate pink blossoms first and then add the green.

The teacher may again sketch a long stretch of horizon on the board, showing perhaps the elements spoken of in the poem, "the sky and sea" and "rocks and trees;" let the children choose a composition from it with their finders, and then draw the principal forms very lightly before painting. See the illustration below.

Try several simple color impressions representing different times of day by different color schemes in sky and water. A sunset, an afternoon or a morning scene may be represented.

57. Second Week. Decorative Landscape. When the landscape is used to decorate a book cover or magazine, it is rendered in a purely decorative way, which means that the various elements are drawn carefully and the color is applied in a flat wash. Use either black and white and gray, or color, using tones of one color, like light and dark green, or blue, or a combination of a few colors, always mixing the colors to produce a gray.

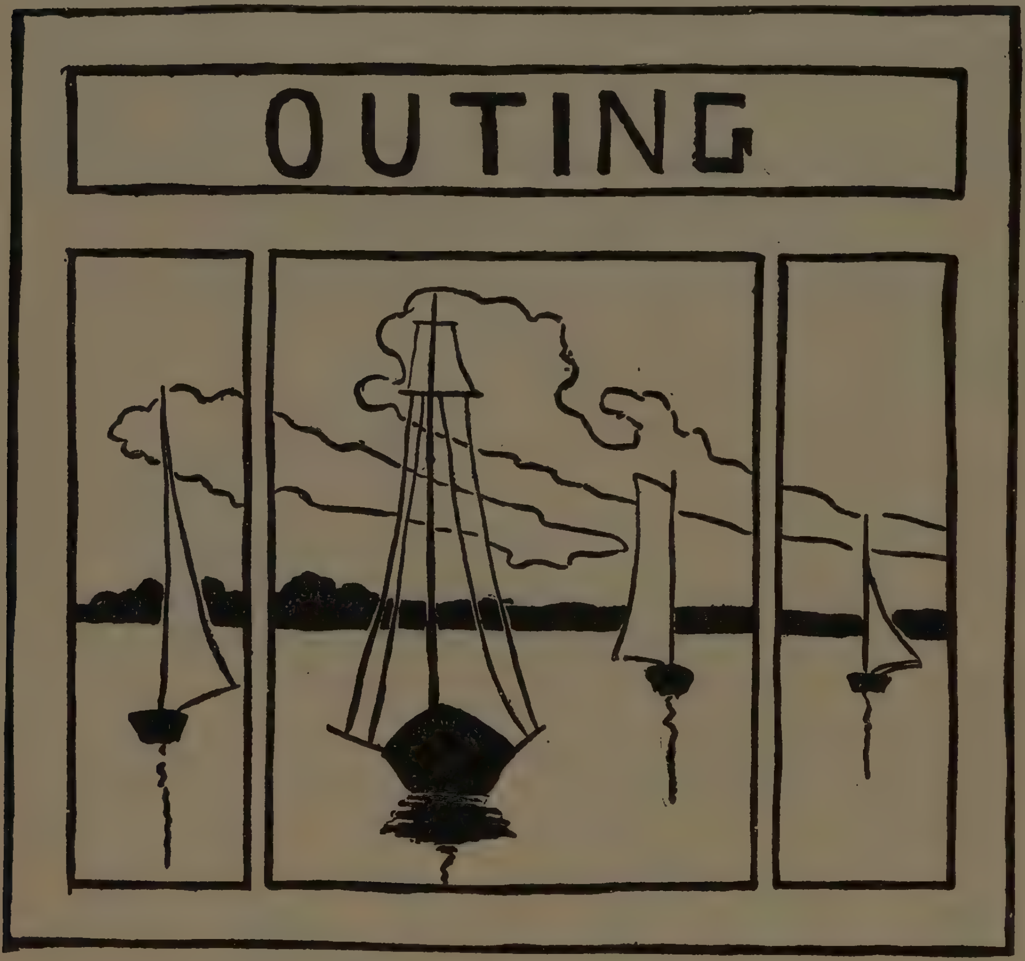


HORIZON STUDY, ILLUSTRATING USE OF FINDERS

Draw the landscape composition carefully, using a motif from the blackboard sketch previously made. After the drawing is made, decide which parts of the landscape should be light and which dark. With a little ink or black water color mixed with water, apply the tone for the sky, then a darker color for the ground, and a very dark color for the trees, using more ink or water color where the darkest color is desired.

Try this lesson first with black and gray, then with tones of one color, as green or blue, using light and dark tones, as in the previous study.

58. Third Week. APPLICATION OF DECORATIVE LANDSCAPE. A portfolio or envelope in which the term's drawings may be kept will make a fitting problem to close the year's work.



DECORATIVE LANDSCAPE

The pattern for the envelope was given in September work (see page 385, Section 21). If the portfolio is desired, the following materials are necessary: Two pieces of cardboard 12 x 14 inches; a piece of toweling 16 x 28 inches, or bogus paper, for covering. The paste may be either library or flour paste.

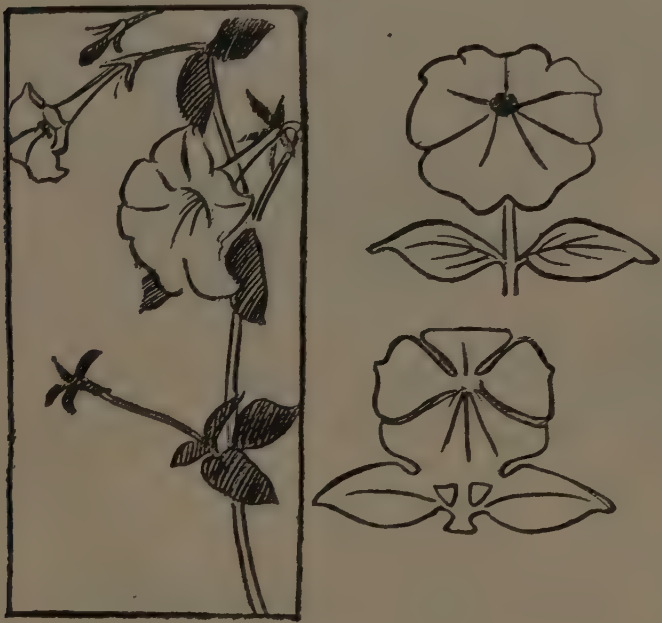
Paste a strip of paper or cloth between the two pieces of cardboard, to form the back of the portfolio, allowing a space of an inch between them. Cloth is better than paper, because it makes a stouter back. Any cotton cloth will be satisfactory. Cut the covering (bogus paper or toweling) large enough to cover the two halves of the portfolio, and leave an inch to spare all around, to fold over as a lap. The covering may be pasted down flat on the boards, or it may be creased and the lap only pasted down.

DESIGN FOR BOOK COVER

The lining paper should cover the inside up to within a half inch of the edge, and should be pasted all over to insure its being flat. Manila paper will serve very well for a lining. An extra strip should be pasted down the back before the lining is pasted on the inside of the covers.

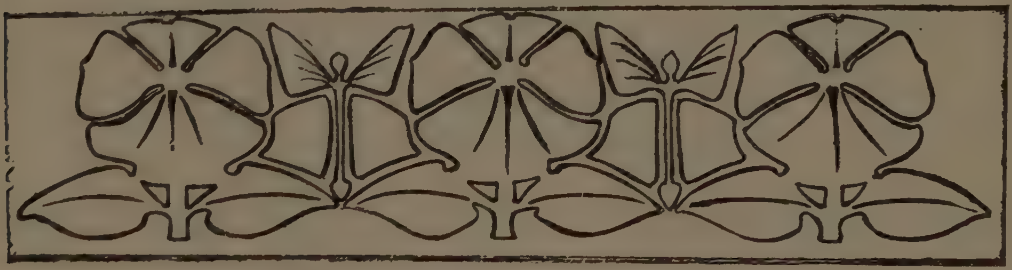
Decorate the portfolio with the decorative landscape previously drawn. Paint it in black or tones of one color. If the toweling has been used for the cover, use a little paste with the colors to prevent them from spreading.

The word *Drawings* or *Portfolio* might be added to the decoration. Great care should be used in planning the letters, drawing a line at the top and bottom, and spacing the letters equally. Use plain block letters.



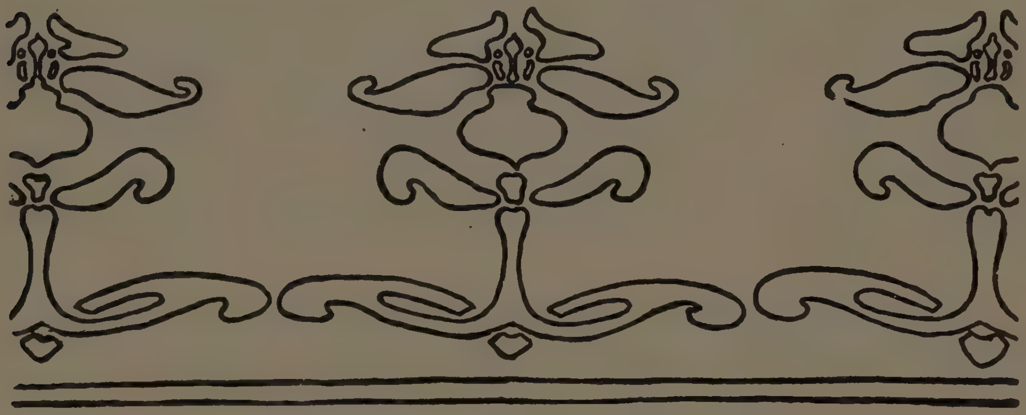
DESIGN FROM PETUNIA

Instead of a decorative landscape, a conventionalized flower in a border might be used across the front cover of the portfolio. Choose some simple flower form, like the tulip or petunia (see the illustration), and draw the outline of form and cut a paper pattern of this unit, which may be traced around to make a design on the cover. Plan the space to be decorated. Commence in the center to place the pattern, and use as many units as the space will permit.



CONVENTIONALIZED DESIGN FROM PETUNIA

59. Optional Problems. The whole month of June may be used in making and decorating something useful for the home. Pillow covers or curtains may be stenciled, using a conventionalized flower motif in a design. After the flower has been chosen and studied carefully, have the pupils make a careful drawing, or painting, as the flower studied may suggest. They should take one flower and make a careful drawing of the top, or front view, leaving an open center and the petals separated to suggest a stenciled design, as the magnolia design in the border herewith reproduced suggests. Such a border would make a very appropriate design to use as a stencil on curtains or a pillow.



MAGNOLIA DESIGN FOR BORDER

Let the final work of the year be a problem which includes the application of art to something both useful and beautiful for the home. In this way fine art will become useful art, and the useful arts become fine arts.

Test. Make a design suitable for a curtain, using some flower motif. Paint the design in two colors or in ink.

Of what value is art training in the home and in the school?

CHAPTER THIRTEEN—Continued

PICTURE STUDY

60. Selection of Pictures. The use of pictures to illumine all the work of the schoolroom needs no discussion at this period of educational advancement to prove its value. It is often only the question of what pictures are available to illustrate the reading, geography, history, nature and art study, and where they may be obtained, that the enterprising teacher is asking.

Besides the pictures used merely to illustrate other subjects, there should be added the study of some of the great masterpieces in painting and sculpture, and the inexpensive reproductions of these famous works of art are the best means afforded to become acquainted with them. If one or two new pictures were presented to the children every month, they would know a representative collection at the end of the eighth year.

The teacher will choose those pictures she thinks will be most interesting to her pupils. The pictures of animals, country life and activities, figures, landscapes and historical subjects are, in the order enumerated, interesting to children. Some of the pictures will be found especially helpful to use in connection with the lessons in landscape and figure work; notable among these are the Corot pictures in the former, and Millet pictures in the latter case. Some of the pictures, especially those of Madonnas, are most appropriate for study at the Christmas season. Others will be helpful to the work in history. This is particularly true of some of the works of Italian artists.

61. Method of Study. (1) Allow the children to enjoy the pictures without much discussion on the part of the teacher, then by a few questions lead them more fully to appreciate the message the artist intended to convey.

(2) Learn something of the life of the artist and the century in which he worked.

(3) If the picture is a landscape, study it to get the character of the country, time of the year, mood of the day, or characteristics of the trees or sky or ground which the artist wished to reveal. Can you tell the time of day by the color contrasts, that is, by the effects of dark and light, or the length of the shadows?

(4) If the subject is a figure, study to see the message or story it contains. Does it tell of work or play, or is it a portrait which expresses well the individual characteristics of the sitter?

(5) Do not fail to speak of the beauty or strength of line in the figures, the placing of the figures in the landscape setting, the simplicity of environment, the naturalness of pose, and the national characteristics in dress and feature.

62. Helps. For helps along the line of picture study, try to obtain copies of the works of Estelle Hurll, who has written interestingly on many of the great artists; also Mrs. Wilson's *Picture Study*. If possible, obtain back numbers of the *Perry Magazine*. *How to Enjoy Pictures* by Mabel Emery, and any of Russell Sturgis' books on art topics are very valuable.

63. The Last Supper, by Leonardo da Vinci. "Great men never come singly," says Emerson. True it is that at the close of the fifteenth century there lived in Italy a most illustrious group of art workers, and history records other instances where leaders have come in groups. We recall in our study of Raphael that he was one of the talented young artists of this period. A galaxy of great lights shone around him that in some respects even eclipsed the meteor-like Raphael, whose life flashed brightly for a few short years and then vanished from sight.

Among the most noted luminaries of the time were the great Michelangelo and Leonardo da Vinci. Leonardo, as he was familiarly called, was not only an eminent painter, but a sculptor, an architect, a musician, an engineer and a scientist.

Leonardo was born in the year 1452, in the little mountain village of Vinci, near Empoli, rising with its fortified castle and white houses from dark woods on a hill west of Monte Albano. His father was Signoria of Florence — Ser Piero da Vinci — a man of twenty-five. His mother belonged to the peasant class. The boy was brought up by his father's parents at their country seat in Vinci.

He was educated by his grandparents with loving pride. Even as a young man Leonardo must have been of a restless, investigating spirit. There is no domain of creative art in which he did not try his hand. In early youth he felt the impulse to commit to paper in drawing or writing the innermost feelings of his soul, and in doing so, he developed all his rich gifts in harmonious proportion. The artist always kept an even pace with the scientific investigator. It is therefore difficult to prove which is greater, Leonardo the artist, or Leonardo the scientist. From his letters one is surprised to learn of his wonderful versatility. He claimed to have made models of a steamship, a flying machine, wonderful inventions to use in time of war,— such as bombs, temporary bridges, subterranean caverns, engines throwing stones, ships able to resist the largest bombs which could create dust and smoke,— and many other things. He shared the fate of many discoverers whose inventions are rendered practically useless on account of a lack of appreciation. Many drawings of his inventions have been saved, which prove the truth of his statements, but at the time his inventions were considered worthless. However, nearly all of them have since been reproduced by others and are now in use. But it is Leonardo's work as an artist that we wish to study.

At the age of sixteen he entered the studio of Verocchio, in Florence. His drawings, made before this time, astonished his teacher who advised that the youth be trained as an artist. The story is told that he was given the privilege of painting on a picture begun by his teacher, and that the

THE LAST SUPPER

figure of an angel painted by Leonardo looked much better than the figures painted by Verocchio. Another story of the young painter's genius is that his father gave him a beautiful piece of wood, and Leonardo had the idea to paint something on it which would have the same effect on the beholder as a shield with the head of the Medusa. To reach this end, he caught tiny lizards, crickets, snakes, bats, and other strange creatures, and shut them up in a room which no one but himself entered. After having studied these animals he painted a frightful monster issuing from a dark den, exhaling poison from its open jaws, its eyes aglow with fire. The picture terrified his father when he first saw it. It was later bought by the Duke of Milan for 300 ducats.

There are few pictures that are known to be the work of Leonardo, but those that are authentic are masterpieces in form and color. His ability as a portrait painter is proven by several celebrated pictures, notably the *Mona Lisa* and *La Belle Feronnière*, pictures of beautiful Italian women, both in the Louvre gallery in Paris. Several Madonna pictures and other Bible characters are in the galleries in Italy and other European countries.

The most celebrated of Leonardo's works as an artist is his painting *The Last Supper*, which is in the Refectory (dining room) of the Monastery Santa Maria Delle Grazie, in Milan, Italy. It is a large mural painting, the figures life size and representing Christ and his twelve apostles seated at a long table, partaking of the last supper before his death. The impression produced on the spectator by the original painting is so great that one only perceives by degrees the thoughtful plan of the whole,— the strictly symmetrical arrangement of the Apostles in groups, each composed of three figures arranged either side of the Christ. The Apostles represent all the types of human character and temperament. The figure of Christ is one of divine resignation.

The tragic moment that is represented in the picture is the one after Christ has pronounced the momentous words that fell like a thunderbolt amongst the unsuspecting disciples,—"Verily, verily I say unto you that one of you shall betray me." Every one of the disciples shows his temperament, his disposition, his innermost feelings, not only in the face but also by the hands stretched out towards his Master. The guilty Judas is the dark face, the second figure on the right of Christ. He clutches the money bag in his right hand, a symbol of his guilt. In the convulsive agitation with which Judas holds the bag when his treason is revealed, he has upset the salt cellar with his right arm. From the time of the old Romans this has been an evil omen with those partaking of a meal. The figure at the back of Judas is the angry Peter, who rises instantly ready for combat, pressing his hand with the knife against his side, as he leans over to ask John, the beloved disciple, who sits at Christ's right hand, whom the Master really meant. He shows through his violent agitation that he is ready at any moment to draw the sword against anyone in order to protect his Master. In the group at the left of Christ are Thomas, James the Elder, and Philip. At the extreme right are Thaddeus, Matthew and Simon, and at the left are Andrew, James the Less, and Bartholomew. Leonardo had striven to depict the character of every one of these men from a study of the Apostles, the Evangelists and the Fathers of the Church. Notice that all the figures are either looking toward the Christ or are extending their hands in his direction, so that he is made the center of interest. Even the lines in the room, the ceiling and windows would converge and form a vanishing point at Christ's head.

It is said that Leonardo left the head of Christ unfinished because in the end he was unable to carry out the ideal he had before his eyes. The head of Christ is placed before the broad middle window of the background, and hence he alone appears surrounded by the bright celestial light as by a natural halo. The colors in the original painting on the wall of the Monastery are much subdued and, in some cases, nearly obliterated. The picture has suffered many abuses in the centuries since it was painted. When Napoleon's army was stationed at Milan, the room in which the *Last Sup-*

per was painted was used as a stable, and a door was cut through the wall, destroying the lower part of the picture. But through reproductions the great masterpiece will be saved to help teach men the utter folly of the greed of gold, and that the spirit of truth, as expressed in the Christ, can never die. Although crucified it will rise again and be the greatest object lesson upon which to build character. Leonardo's name will live as one of the most able artists in the delineation of character and human emotions.

Leonardo's late years were passed in Milan, where he founded a school, which in view of its wide influence may be styled one of the great Italian schools of painting. His last days were spent in a beautiful residence which King Francis I assigned to him, and there he spent most of his time in scientific research. He died on the second of May, 1519, surrounded by a group of faithful friends, and was buried with a display of splendor he so loved. Although from his writings one learns that he outgrew the tenets of the prevailing church, yet he bequeathed part of his fortune to it, and part to several faithful friends and relatives. In his passing away the world lost a thinker and a doer, whose life work has enriched the ages.

64. The Horse Fair, by Rosa Bonheur. Let us all look at this picture quietly for a few moments and then some pupil may tell us all that he saw in the picture. Where did you ever see such a group of fine horses? How many enjoy looking at the stock at the Fair? Which of these horses do you think would take the prize? Which ones would you choose for heavy work? These are called draft horses. We often see them hitched to heavy loads in the city streets. Which do you think might be fine race horses? Which would you like for a pet?

The artist who painted this splendid picture was very fond of pet animals. When a little girl she lived with her parents and brother and sister in the sixth story of a large tenement house in the great city of Paris, France. Her name was Rosa Bonheur. Her father was an artist and encouraged Rosa to become an artist, too.

Her first picture to be exhibited at the French Salon (Spring Exhibition) was painted when she was but sixteen. This was a great honor. It represented some pet rabbits eating carrots. She used to accompany her father to the great gallery, the Louvre. Here she would paint all day, and, as women were not allowed this privilege, she dressed like a boy. She found it more convenient to dress in man's attire when she went into the country to study and paint pictures of cattle and horses; so she received permission from the government to garb herself as a man. A picture of her represents her with short hair, a loose blouse and one arm over the neck of a young bullock. On the front of her coat is seen the medal of the Cross of the Legion of Honor, which was given her by the French government in honor of her work.

She lived during the greater part of her life in the little village of By (pronounced Bee) near Barbizon, where the colony of artists lived. They were often somewhat displeased at the noises made by her pets, as she had several wild animals — lions, among others — that made her home quite like a zoological garden. It is said they were quite jealous also of the great success that came to her in making ready sales of her pictures.

She is considered the greatest of animal painters, and her travels to study them often took her great distances. She spent some time in Spain in the Pyrennes Mountains studying mountain goats, and in Scotland, where she pictured the long-horned cattle grazing in the Scottish highlands. She has made excellent pictures of deer and lions, besides many domestic animals.

This picture, called *The Horse Fair*, is one of her most famous pictures, and was painted on the largest canvas ever woven — made especially wide at her request. The horses are nearly life-size in the original painting, which is in the Metropolitan gallery in New York City. It is so realistic that one wonders if those splendid horses will not prance right out of the frame. The picture was originally purchased by the wealthy American gentleman, Mr. A. T. Stewart, who paid

From a painting by Rosa Bonheur

THE HORSE FAIR

$10,000 for it in Paris, and presented it to the New York gallery.

Did you ever try to draw a picture of a horse? Would you like to try to do so from one of these? You could do it in black silhouette, just to show the form, or try free hand cutting to represent it. Would you like to bring your pet to school and let us draw from the living model? A cat, dog, bird, rabbit, squirrel or any other animal would make an interesting study. One time in the public schools of Indianapolis, the children brought their pets for work in drawing, and it proved to be a most joyous occasion. The children learned a great deal about the different animals and enjoyed feeding them.

Animals are often very devoted friends of man. Think of what service the horses have been, which only ask kind treatment and food in return. We are often very dependent upon their willingness to serve us, and we should always be kind to them.

It is told by a friend of Rosa Bonheur that her pet pony, which is represented at the left of the center of the picture, once got so near the canvas upon which she was painting, that he accidentally put his foot through it, and of course ruined the picture. Rosa, it is said, did not get angry at him but knew it was her own fault that she allowed him so near.

She devoted her life to picturing her animal friends, and the world is much richer for her having lived. She died in 1899 at the age of 77 years. She devoted her entire life to her work.

(a) QUESTIONS. What is the name of this picture? Where was it painted? Who was the artist? Do you know of any other great animal painter? Where did he live? What animals did he love to represent? Do you know the names of any of his pictures? (Reference is made to Edwin Landseer.) Which one do you like the better, Edwin Landseer or Rosa Bonheur? (Rosa Bonheur is considered the greater artist. Landseer had profound admiration for her and her work.)

Tell the story of her childhood. Did she like to go to school? Why? What great gallery in Paris did she work in with her father? How was she honored by the French government? Where would you go to see the original painting of the Horse Fair? Who bought it and what was the price paid for it? Could you collect and bring to school other pictures of animals and let us make a fine collection to use in our story-telling exercises? Do you know any good stories about animals? Do you know the stories of Ernest Thompson Seton? He often illustrates them, too.

65. Dance of the Nymphs, by Camille Corot. Would you not like a frolic under such beautiful trees as this picture represents? Have you woods near your home? What trees do you know? Could you make a picture of the maple, oak, elm, poplar or apple tree? We will try making tree studies in our next drawing lesson.

Let us look carefully at this grand group of trees in the picture. Do you know what kind of trees they are? They resemble large willow trees, I think. The artist, Camille Corot, a French painter, loved the trees so much that he studied them during his long lifetime, spending, as he said, fifty years in the "out-of-doors," making landscape pictures representing the scenery around Paris and the little French village of Barbizon. He made a trip to Italy when a young man, and this picture was painted during his sojourn in that beautiful country. He loved best the trees with a delicate foliage, such as the willow, the aspen, birch, elm, etc. His favorite time of the year was the springtime when nature gowns herself in lovely greens. Often he chose a tree that was just coming into delicate leafage, showing many branches with a thin veil of green over them. The *figures* he puts in his pictures are always at play and seem so happy and care free. How many figures can you see in this picture? They represent some of the play spirits in Greek mythology, called *Nymphs*. Sometimes figures part animal and part human are described, called *Satyrs*. Can you find a figure that has legs like a goat? He is a Satyr called Pan, who was supposed to frolic on the sacred hill of Olympus in Greece. Corot was fond of representing figures in mythology, and, as he often attended the opera, he

From a painting by Corot

DANCE OF THE NYMPHS

would put these classical figures in his pictures. He represented Orpheus, the god of Music, in some of his pictures.

Corot was a great lover of music and played well on the violin; he also had a good voice. In a letter he wrote to a friend he described "a landscapist's day as divine," in the following words:

> One is up by four in the morning and out waiting for the break of day. You watch and wait and listen for the first signs and sounds of coming day. Then a faint flush is seen along the horizon; the first tree toad croaks and the whir of some insects' wings are audible. You watch and listen and presently the whole sky is aglow. Bam! the sun has arisen and bathes everything in a blaze of glory. I paint and paint and sing and sing! Soon it becomes too bright; all the poetry of the morning vanishes and I must dream it all over again. Nothing but the intangible is splendid.

Corot was one of the first artists to study nature in the open and his pictures were the wonder of the art world of his day. Although he worked twenty-five years before he sold a picture, he mourned then to see it go, as he thought of his works of art as his children. His life was a carefree, happy one, surrounded as he was by a group of devoted art friends at the edge of the forest of Fountainebleau in the little village of Barbizon. Here Millet, Corot, Rousseau and several other artists lived in happy communion, "painting the things as they saw them, for the God of things as they are." He died in 1875, at the age of eighty-one, beloved by all who knew him and leaving the world a rich heritage in his large collection of beautiful landscape pictures.

Examples of his work may be seen in the Chicago Art Institute, Metropolitan Gallery, N. Y., and in the Louvre Gallery in Paris. His pictures are considered priceless and command fabulous prices in the picture markets of the world. In his lifetime he sold few pictures and worked for the real love of his art. He was very generous and often helped his fellow artists who were less fortunate than himself, financially. He was especially kind to Millet and his large family, who lived near to him at Barbizon.

Corot's father and mother kept a fashionable shop in Paris, and they were very much disappointed that their son

Camille did not wish to follow their profession. But after repeated trials and failures to make a shopkeeper of him, they let him have his own way and promised him a dollar a day until he could establish himself in his profession. As long as he had "soup and sole leather" he said he was content to paint and make pictures, whether he sold them or not. He used to visit the Louvre and admire the work of the great French landscape painter, Claude Lorraine. He often wondered if he could ever learn to paint as well as this master. If you visit the Louvre now you will see examples of Corot's work hung beside this master which he so much admired. People learned to like Corot's work so much that they used to say there was real nature and Corot nature. When he died his funeral was attended by hundreds who mourned his loss, and who always called him *Papa Corot.*

(a) QUESTIONS. What artist made a special study of trees? What kind of trees did he love the best? What time of the year did he choose to represent? What time of the day? How can you tell this by his pictures, although they are not colored? What is the name of the picture represented? Why is it so-called? Where do you read about Nymphs and Satyrs? Can you tell something of Corot's early life? What were his parents? Where did they live?

What little village did Corot choose to live in? What other artists lived in this village? Do you know the names of any great pictures they painted? What great animal painter lived near Barbizon? What great masterpiece did she paint? Could you collect other pretty landscape pictures for our school collection? Did you ever use a kodak and make some pretty pictures? Could you choose some compositions like those Corot made? Let us start a collection of different tree studies and try making tree pictures ourselves.

66. A Statue of Moses, by Michelangelo. Do you know a great character in Bible history who was a leader among the Jewish people? This picture represents a statue of this man; his name is Moses. You will remember the story — how his mother hid him, when a baby, in the bulrushes, and how he was found by Pharoah's daughter, who adopted him, thereby saving his life, as Pharoah had said that all the boy babies of the Jewish people should be slain. Thus he was educated in the household of the King of Egypt. He seems to have been saved to deliver the Jewish people from their bondage under the cruel Egyptian King. The story tells of the miracles performed by God through Moses, and how the Egyptians were punished because Pharoah would not let the Hebrews leave the country to go to the land of Canaan. After the final departure of the Hebrews, Moses was made their leader and law-giver, and was considered a very wise man. The Bible tells us that God spake to Moses and gave him the ten commandments that were to be laws for his people.

This statue of Moses represents an old man of great strength, as symbolized by his long beard, and possessing great wisdom, as symbolized by the horns growing from his head. In his hands he holds the tablets of stone, upon which the commandments were graven when he went up to Mount Sinai. This statue was carved in marble by the great artist Michelangelo, who lived in Italy in the sixteenth century. He was born in 1475 and was a youth of seventeen when his fellow countryman, Columbus, discovered this continent. Michelangelo was a painter, a sculptor, an architect and a writer, and he left masterpieces which place him among the immortals in the world of art.

He was often employed by the Church to portray Bible stories and characters, and the cities of Florence and Rome are full of examples of his wonderful works. At one time the Pope wished Michelangelo to make a great monument to mark his (the Pope's) burial place. One of the figures that he carved for this was Moses. The monument was never completed and so the statue of Moses was placed in the large Catholic Church in Rome, called St. John the Lateran. Do you notice the strong muscular arms and limbs in the statue? Michelangelo's figures are always characterized by great physical strength. The pose is powerful and kingly, and the face portrays a thoughtful mind. Although the figure was doubtless made from an Italian model, it is so emblematic of strength and wisdom that it is considered the greatest statue representing Moses that has ever been created. Michelangelo's life and work is so interesting that perhaps you would like to know more about him.

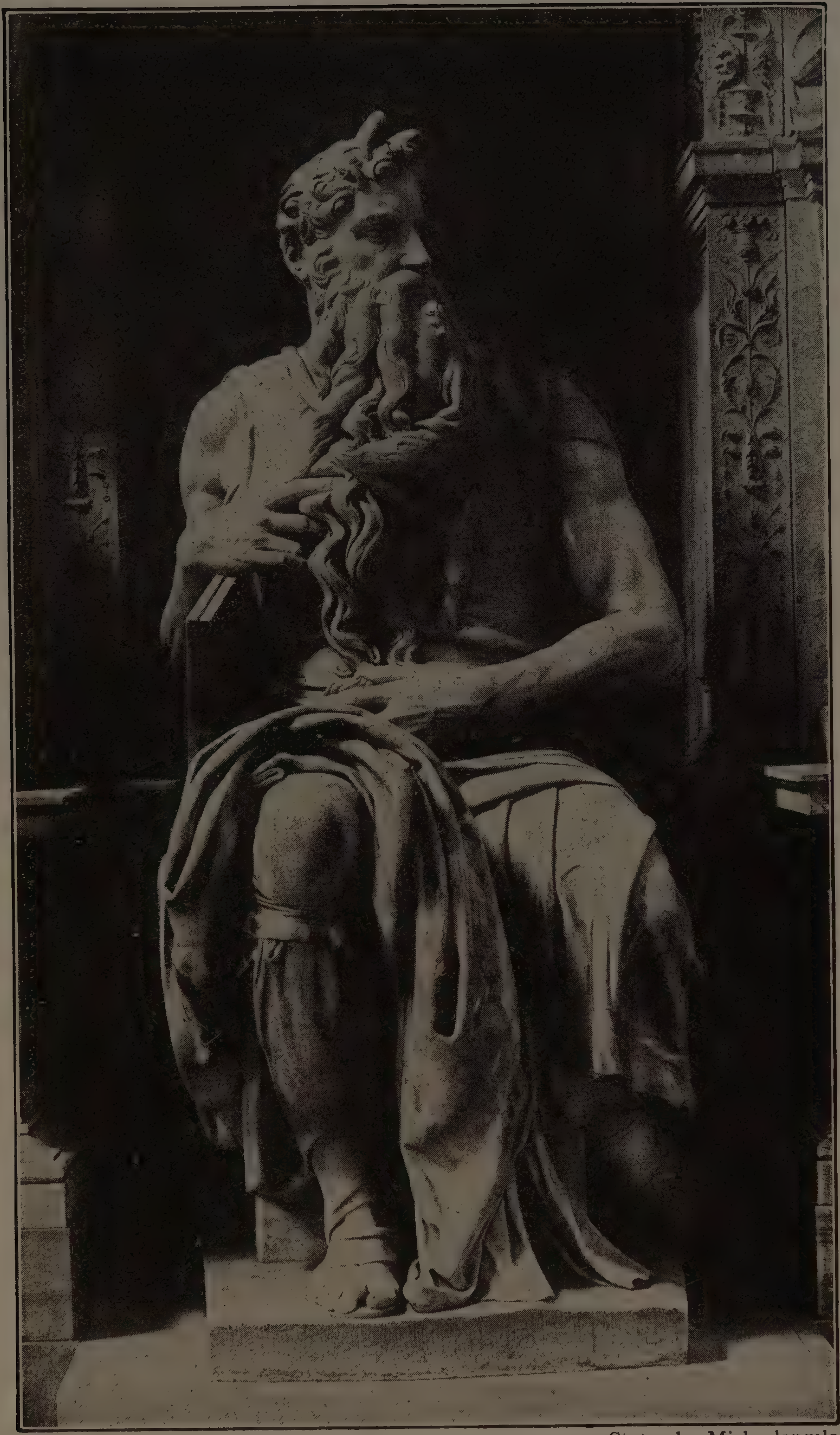
When a young lad he studied modeling in clay and marble cutting in the school supported by the rulers of Florence, called the Medici Family. He was talented even as a young boy. He unfortunately had a very quick temper. One day he provoked a young man working with him, who was also quick-tempered, and who hit him a blow with his mallet, striking him on the face and breaking the bone in his nose. His picture which he made of himself in after years shows a deformed nose.

When quite young he made a statue of Christ represented as dead in the arms of his mother, which was placed in the great Catholic Church of St. Peters in Rome. He did not carve his name on it and people doubted that such a wonderful statue could be the work of one so young. It is told that one night he crept into the church, and with the light of a lantern carved his name upon it. He was ever afterwards sorry that he did so, for he had boasted that his work should be so much stronger than that of any other artist that every one would know it was his work by its great individuality, without his name.

It was Michelangelo who planned and perfected the greatest dome in the world at that time — the dome of St. Peters. It is 430 feet high. Do you know that beautiful little poem of Longfellow's that describes this work:

> The hand that rounded Peter's Dome,
> And groined the aisles of Christian Rome
> Built in a sad sincerity.
> Himself from God he could not free;
> He builded better than he knew;
> The conscious stone to beauty grew.

Michelangelo was a painter also, and painted the walls in the Sistine Chapel which is in the Vatican, adjoining St. Peters



Statue by Michaelangelo

MOSES

Church. He represented on the walls and ceiling Bible stories and characters; many of his figure paintings look as real as if they had been carved in marble and placed in the niches in the walls. His painting called "The Last Judgment" on the ceiling of the Chapel is a marvelous creation containing hosts of figures. It was so difficult to paint — being on the ceiling — that he built a scaffold and lay on his back much of the time while working. It is said that he strained the muscles of his neck while working here and that he was obliged to walk with his head thrown backwards for many months.

He lived to be eighty-nine years old, passing away in 1564. He devoted his life to his chosen field of art. In his advanced years he wrote sonnets that are considered masterpieces in literature. Rudyard Kipling wrote an appropriate poem that might be used in thinking of the life of Michelangelo:

> When earth's last picture is painted,
> 　　And the tubes are twisted and dried,
> And the oldest colors are faded,
> 　　And the youngest painter has died,
> We shall rest, and faith we shall need it,
> 　　Lie down for an eon or two,
> Till the master of all good workmen,
> 　　Shall allow us to work anew.
>
> And those who are good shall be happy;
> 　　They shall sit in a golden chair,
> And splash at a ten league canvas
> 　　With brushes of comets' hair.
> They shall have live Saints to work from,
> 　　Silas, Peter and Paul.
> They shall work a year at a sitting,
> 　　And never grow tired at all.
>
> And only the Master shall praise us,
> 　　And only the Master shall blame;
> And no one shall work for money,
> 　　And no one shall work for fame —
> But all for the love of the working —
> 　　And each in his separate star
> Shall do the thing as he sees it
> 　　For the God of things, as they are.

(a) QUESTIONS. How many Italian artists do you know? Who was a painter of Madonnas? What pictures of his have you seen? Who was a great sculptor, architect and painter? When did he live? Tell something of his boyhood. In what cities did he work? What great church did he plan? What statue in the church is the work of his hand? How do people know Michelangelo's works? Did he put his name on them? Why?

What statue did he carve for a monument for the Pope? Can you describe it carefully? How did he express Moses' great strength? His great wisdom?

Have you ever tried to illustrate stories? In the early times before books were common, the people learned much through the pictures painted in churches by artists. Have you paintings in your church? Have you pretty stained glass windows? Could you collect pictures of great churches and Bible characters to learn something of this phase of art? When you go abroad this kind of art will be very important, and you will see great churches and much religious art.

67. Lists for Reference. (a) AMERICAN ARTISTS. Stuart, portraits of *George Washington* and *Martha Washington*; Boughton, *Pilgrims Going to Church*, *John Alden and Priscilla*; Blashfield, *Christmas Chimes*, Abbott Thayer, *Caritas* (*Charity*); Sargent, *Frieze in Boston Library.*

(b) ENGLISH ARTISTS. Turner, *The Fighting Temeraire*, *Venice*, *Wreck of the Minotaur*; Millais, *The Princess in the Tower*; Burne-Jones, *The Golden Stair*; George F. Watts, *Sir Galahad*; Rossetti, *Dante's Dream*, *The Blessed Damosel*; Landseer, *Highland Shepherd's Chief Mourner*, *Dignity and Impudence*, *Member of the Humane Society*, *The Deer Pass*, *The Connoisseur.*

(c) FRENCH ARTISTS. Rosa Bonheur, *The Horse Fair*, *Coming from the Fair*, *Ploughing*, *Cattle in Brittany*, *Landais Peasants*, *Scotch Cattle*; Troyon, *Return to the Farm*, *Oxen Going to Work*, *Landscape with Sheep*; Millet, *The Sower*, *The Gleaners*, *The Angelus*, *Going to Work*, *Sheep Shearing*, *Potato Planting*, *Shepherdess Knitting*; Julien Dupre, *Haymakers' Rest*, *Pitching Hay*, *Before the Storm*; Corot, *Dance of the Nymphs*, *Lake Albano*, *The Lake*, *Landscape with Willows.*

(d) DUTCH ARTISTS. Rembrandt, *The Night Watch*, *The Anatomical Lesson*, *Rembrandt's Mother*, *Saskia* (his wife); Mauve, *Shepherd and His Flock*, *The Returning Sheep.*

(e) FLEMISH ARTISTS. Van Dyck, *Children of Charles I*; Rubens, *Portrait of Himself, Descent from the Cross*; Alma-Tadema, *Reading from Homer.*

(f) German Artists. Schreyer, *Arabs on the March, Arabian Outposts, A Halt in the Oasis*; Hofmann, *Christ in the Temple, Christ and the Rich Young Man, St. Cecelia*; Holbein, *Madonna of the Burgomaster Meyer, Martin Luther, Luther's Wife*; Durer, *Portrait of Himself, Adoration of the Magi.*

(g) Italian Artists. Michelangelo, *David, Moses, The Fates*; Raphael, *Sistine Madonna, Transfiguration*; Botticelli, *Allegory of Spring*; Leonardo da Vinci, *Mona Lisa, The Last Supper.*

(h) Spanish Artists. Velasques, *Portrait of Himself, Portrait of Philip IV*; Murillo, *The Madonna and Child, Immaculate Conception, The Melon Eaters.*

(i) Greek Sculpture. *The Parthenon*; *Venus de Milo*; *Hermes*, by Praxiteles; *The Fates* (from the Parthenon); *Victory of Samothrace*; *The Wrestlers.*

TEST QUESTIONS ON DRAWING

1. What are some of the advantages derived by the pupil from a course in public school drawing?

2. Why should the teacher herself be able to draw?

3. How can the work in drawing for the fall and spring months be correlated with nature study?

4. What are the fundamental principles to be taught in a lesson on holding the pencil?

5. Give simple and correct definitions of the following terms: *horizontal line*, *vertical line*, *oblique line*, *oblong*, *diameter*, *diagonal.*

6. Show how you would teach the subject of drawing grasses: of flower painting.

7. What is the value of a school exhibit of drawing work? How should such an exhibit be arranged?

8. Show how you would correlate the work in drawing with written lessons.

9. Outline a model lesson on trees; on autumn flowers.

10. How should a lesson on fruits and vegetables be conducted?

11. Suggest timely subjects for November lessons.

12. How can the drawing lessons be correlated with early American history?

13. What are working drawings? How are they utilized in construction work?

14. How would you develop the lessons on making a work basket?

15. What is meant by a *conventionalized form*? A *stencil*?

16. Name and define twelve type solids.

17. How would you teach the principles of perspective?

18. How would you apply the laws of perspective in teaching the pupils to draw rectangular objects?

19. What are the essentials of good arrangement in grouping objects?

20. Outline a lesson on drawing the human figure.

21. Outline an ideal method of studying pictures.

22. Show how such a method could be applied to the study of the life and work of Leonardo da Vinci.

QUESTIONS ON PICTURE STUDY

1. What is the recognized value of picture study?

2. What should be the nature of pictures on the walls of the schoolroom?

3. Of what value to pupils are pictures of historical subjects? Of landscapes? Of animals?

4. What masterpieces of art should be studied during the fall? At Christmas time? During the spring?

5. Did the artists of the Middle Ages work for the love of art or for monetary reasons?

6. What moment in the life of Christ is represented in Da Vinci's *The Last Supper*?

7. What artist ranks foremost as a painter of still water, sleepy woods, hazy skies and ethereal clouds?

8. What is the hidden beauty in Raphael's *Sistine Madonna?*

9. How many fingers are on the right hand of Pope Sextus?

10. Tell the story of the little Cherubs at the bottom of the *Sistine Madonna.*

CHAPTER FOURTEEN

DOMESTIC SCIENCE

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INTRODUCTION

1. Why Domestic Science Should be Taught. The home should be an earthly paradise, the haven where, after the day's toil, the members of the family can find rest and peace; a bower of beauty in which the young receive their first ideas of refinement; the abode of love, where each shares the other's joys and sorrows, where high ideals are formed and evil passions suppressed; the center around which clusters all that is best and noblest in life. Whatever the public school can do to make the home more attractive and to bring it nearer a state of perfection should be considered a part of its legitimate work. Among the reasons for placing domestic science in the course of study of public schools, the following are important:

(a) GROWTH OF CITIES. Recent changes in our industrial system have in many instances compelled us to adopt new methods of living to which our former practices are not well suited. The development of the large corporation has brought people into centers of population until over one-half of the inhabitants of the United States now live in incorporated cities and towns.

(b) NEW HOME CONDITIONS. Formerly the home was the center of many lines of industry. The women of the household not only prepared and cooked the food and cared for the house; they also spun the yarn, wove the cloth and cut and made the garments for the family. A girl who reached her twentieth year without becoming skilful in these various occupations was not considered to be adequately prepared for the duties of life. Now all this is changed; practically everything can be obtained from the factory and the store ready for use, while in towns *bakeshops* supply all varieties of cooked food. The women of the household have given their attention to other affairs, and the old accomplishments are greatly neglected.

(c) PREVENTION OF WASTE. It has been said that the family of a French peasant could live well upon the material which many an American housewife throws in the garbage can. No other nation is so wasteful of the material from which food, raiment and shelter are supplied. Much of this waste is due to ignorance, and some of it to carelessness. Girls should be taught the value of the raw materials and the manufactured articles used in our daily sustenance, and the knowledge thus gained will prevent much of the waste now so common.

(d) REDUCTION OF LIVING EXPENSES. Within the last few years living expenses have increased to such an extent that many families find it difficult to supply their actual needs from their incomes, and the housewife does not know how to reduce expenses and still maintain the standard of living. A more thorough knowledge of the properties and value of the various kinds of raw material from which food is obtained, and of fabrics from which garments are made, constitutes an important step in the solution of this perplexing problem.

(e) CONNECTION OF THE SCHOOL WITH THE HOME. Girls of the intermediate and grammar grades have strong domestic proclivities, and they are easily interested in whatever pertains to the welfare of the home. Lessons in domestic science which are within their mental grasp enable them to make such a connection between the school and the home as will increase their interest in both their school work and their home duties.

2. Difficulties. The teacher who wishes to give her pupils lessons in domestic science in most schools finds herself face to face with numerous difficulties. Among the most prominent of these, the following may be mentioned:

(a) LACK OF KNOWLEDGE. Only a small number of teachers have as yet made any definite preparation for teaching this branch, though most teachers have some practical knowledge of how to conduct a home. Such teachers should use this knowledge as a foundation upon which to build, and by study, reading and experiment obtain the preparation necessary for the work.

(b) LACK OF TIME. This is often a more serious difficulty than the first, for in nearly every school the curriculum is overcrowded. However, wise planning will do much to overcome this difficulty. Many of the nature study lessons and the lessons in elementary science can be so directed as to contribute to lessons on domestic science. This is especially true of those lessons upon articles from which food, clothing and shelter are obtained. Again, many of the principles of cooking are so closely allied with physics and chemistry that some of the lessons upon these subjects will contribute knowledge which can be applied in domestic science. The greatest difficulty is that of providing two lines of work, one for the boys and another for the girls, and finding time to supervise both. But the teacher must remember that these lessons should not be given daily, where the curriculum is already full. By alternating domestic science with other branches, considerable can be accomplished in a year's time even with a crowded course of study.

(c) LACK OF CONVENIENCES. It is only in the larger towns and in cities that we find school buildings fitted up for manual training and domestic science. Lack of space, lack of funds, and, too often, lack of interest on the part of patrons and school officials, compel the teacher of the rural school and the small graded school to depend upon her own resources if she wishes to carry on this work. If the schoolhouse has a basement, and the consent of the directors and coöperation of the pupils can be secured, this can be turned into a domestic science and manual training room. A little ingenuity on the part of the teacher will usually point the way to material accomplishment in this direction. Pupils will often bring from home utensils which can be spared; they will also contribute more or less of the material. Nothing succeeds like success, and when the work is once started, much of the indifference in the community will disappear, and under new conditions which you have created most of the material needed can be obtained.

3. What to Attempt. The kind and amount of work will depend largely upon local conditions, and no definite outline can well be given. In general, the lessons should be upon the essentials, those principles and practices which everyone who manages a home must know. The lessons should also be elementary in character, and in difficulty they should be kept within the capacity of the pupils; there should also be enough variety in the work to sustain interest. Lessons on foods and cooking, on the care of the home, and on sewing and knitting, if rightly interspersed, will afford this variety.

FOODS

4. Preparation of the Teacher. The teacher needs a far more extensive knowledge of foods and foodstuffs than she will ever be called upon to impart to her pupils. The scope of this chapter admits of only an outline of what that knowledge should consist. Further information must be obtained through observation and the study of a few of the many books available at slight cost.

The object of providing food should be understood, namely, to supply the system with proper nourishment; and the knowledge of what constitutes proper nourishment is essential to this understanding. This question being answered, the next query is what articles of food contain these different substances in the proper proportion. From these questions we at once see that a knowledge of the principles of nutrition and the chemical composition of the various articles of food, and how these articles should be cooked, are essential to the successful teaching of this subject. To the theoretical knowledge gained from study, the teacher should add such practical skill as will enable her to illustrate by experiment and practice all the principles and laws discussed in the lesson. She should be able to do well whatever she recommends her pupils to do.

5. Classification of Foods. All substances used for food can be divided into these classes — compounds containing nitrogen, compounds which do not contain nitrogen, and minerals. To the first division the general name *protein* is applied. The compounds of the second division are divided into two classes — hydrocarbons, or compounds of hydrogen and carbon with some oxygen, of which fats and oils are good representatives, and carbohydrates, or compounds containing carbon, hydrogen and oxygen, and having the hydrogen and oxygen in proportions to form water. Starch and sugar are good representatives of this class. The minerals are water, potash, lime, soda, phosphorus, iron, sulphur, chlorine, and a few others of less importance. Water is the most abundant substance in the human system, constituting about three-fourths of the weight of the body, but the other minerals exist only in very small quantities.

6. Protein. Protein includes all nitrogenous foods, and the term is now used in the place of proteid, albumin, albuminoids and nitrogenous foods; and these terms, wherever found in works on chemistry or domestic science, the student should understand to mean the same as protein.

Proteins are divided into three classes — albumins or albuminoids, gelatin or gelatinoids, and extractives. Albumin occurs in the white of eggs, from which it takes its name, the serum of blood, lean meat, the casein of milk, and the gluten of wheat. All of these substances are indispensable to life. Albumin contains a large proportion of nitrogen, and it is employed in building the new tissue in the period of growth and in repairing waste after the system reaches maturity. It also contributes somewhat to the heat of the body. Albumin is soluble in water and weak solutions of salt. Heat coagulates it, as may be shown by dropping the white of an egg into water and gradually bringing the water to a temperature of 180°.

Gluten can be obtained from wheat flour by placing a small quantity of flour (about two ounces) in a bag of cheesecloth or thin muslin, and kneading the flour under running water. The starch is washed out through the pores in the cloth, leaving a stringy, sticky, yellowish substance. This is the gluten and contains albumin. Gluten is also found in barley and other cereals. It occurs in peas and beans in a substance somewhat resembling the gluten of wheat, but of a darker color.

Gelatin is found in cartilage, bone, ligaments, tendons, and some vegetables. Whenever meat containing a large proportion of these tissues is boiled for a long time, the liquor, on cooling, forms a jelly, due to the extracted gelatin. Gelatin contains more nitrogen than albumin, but it is not as nutritious; however, it is easily digested, and on this account is often used in various forms as food for invalids.

Extractives include the juices extracted from meat by soaking it in water, as in the process of making beef tea. They contain nitrogen and perform important functions in nutrition, but, contrary to the general belief, they do not directly contribute to the nourishment of the body; they give flavor to meat, and their presence seems essential to the digestion of muscular fiber. The old idea that beef tea and other extracts of beef are nutritious has doubtless led to death by starvation in many cases. Repeated experiments have shown that gelatin, the juices and fibers of meat, are all necessary to nutrition. This should be remembered whenever meat extracts are recommended for convalescents.

7. Fats. Fats, like protein, are of both animal and vegetable origin. There is practically no distinction between fat and oil. Fat is solidified oil, and oil is melted fat; either can be changed to the other by raising or lowering the temperature to the necessary point. Adipose tissue is formed by an accumulation of fat cells. It is found in largest quantities under the skin, around the viscera, and around the kidneys. Natural fats, as butter, tallow and lard, are composed of a number of fatty acids united with glycerine. Vegetable fats are also composed of several substances, but at ordinary temperatures they retain their liquid form, as in olive oil, castor oil and linseed oil.

Fat contains seventy-nine parts carbon, eleven parts hydrogen and about ten parts oxygen. The small quantity of oxygen is insufficient to oxydize even the hydrogen in the compound. Because of its large proportion of carbon, fat is the most important heat producer among the foods. It also serves to supply nourishment in cases of disease, deprivation of the ordinary supply of food, and of great exertion. In all such instances, the fat is absorbed and the person becomes more or less emaciated. The fat in the body is a storehouse of energy to be drawn upon in a case of need.

8. Carbohydrates. The carbohydrates form one of the largest classes of food stuffs, and one of the most important and most widely distributed of these is starch, which occurs to a greater or less extent in all roots, bulbs, grains and other seeds used as food. To detect the presence of starch in any article of food, obtain from a drug store a little tincture of iodine. Greatly reduce this, then moisten the substance to be tested and place a drop of the dilute tincture upon it; if starch is present the iodine will color the substance blue. Starch consists of minute granules which take various forms in different substances, but which to the naked eye appear as a formless white powder. It is insoluble in cold water, but soluble in hot water, forming a sticky paste. The human stomach cannot digest raw starch; therefore, foodstuffs containing it in any amount need to be cooked.

When starch is heated to 320° or 400°, according to the amount of water it contains, it is changed into a translucent substance closely resembling gum arabic, and known as *dextrine*, or British gum. Dextrine is soluble in water and is digestible; it is formed from cooked starch, when that is acted upon by saliva during mastication.

9. Sugar. Sugar is found in the sap of plants, in ripe fruits, in milk and in a number of other substances. Its chief commercial sources are sugar cane, some varieties of beet and sugar maple. Unlike starch, sugar is soluble to a limited extent in cold water, and to a much greater extent in hot water. As a food, sugar is both a fat former and a source of energy. It is used in many forms, all of which are too well known to need description. In the process of digestion some starch is changed to sugar at the same time that other portions are changed to dextrine. The action producing this change, as already stated, is begun by the saliva during the process of mastication. All carbohydrates are transformed into *dextros*, a form of sugar, during digestion.

10. Mineral Foods. The minerals in the human system exist in the form of salts and acids; that is, the lime, soda, potash, phosphorus and other minerals are not found in their pure state, but in some compound containing an acid and of which they constitute an important ingredient; as, chlorine and sodium are found in common salt; calcium, the basis of lime, in phosphate of lime, and so on. Likewise, these minerals are obtained from eating substances containing compounds of which they form a part. When animal bodies are burned these minerals are found in the ash.

While the minerals found in the system exist only in small quantities, their presence is essential to the maintenance of health and life; hence, in planning the food for the individual or family, care should be taken to see that such selections are made as will supply the system with these substances.

Certain acids found in fruit and vegetables are also essential to the healthy condition of the blood. Chief among these are oxalic, tartaric, citric and malic acids. Since these are all found in vegetable compounds, they are known as vegetable acids. Malic acid is found in apples; oxalic in tomatoes and rhubarb, and citric acid in oranges, lemons and other fruits of the citrus family. Green vegetables and fruits are eaten more for the salts and acids which they contain than for the direct nourishment derived from them.

11. Water. As already stated, water constitutes a larger proportion of the human system than any other substance; there is no organ or tissue that does not contain it, and some tissues are nearly nine-tenths water. Water for household purposes is obtained from springs, streams, wells and lakes, and contains lime and other salts in solution. Water containing a perceptible quantity of lime is known as "hard;" that is, it does not readily yield to soap. Sulphur, iron and magnesia are often detected by the taste they impart to the water. Unless these minerals exist in excess, they are not injurious; but organic impurities, caused by the presence of decaying animal or vegetable matter, are often the cause of typhoid fever, diphtheria and other dangerous diseases. Everyone should know how to test water for organic impurities. Either of the following simple tests can be made by anyone:

(1) Into a vial containing about two ounces of water put a quantity of granulated sugar equal in volume to a pea or small bean. When the sugar is dissolved, cork the vial and set it in a warm place for forty-eight hours. If, when the cork is removed, the water emits a disagreeable odor, it is unsafe.

(2) Make a solution of permanganate of potash by dropping into an ounce of water a few crystals of this substance, which can be obtained at any drug store. Into a glass of the suspected water place a few drops of the solution. If the purple color disappears, the water is unsafe.

These tests are practical and, within certain limits, safe, but all drinking water suspected of pollution should be analyzed by a chemist. Any householder may have this done free of cost by sending a sample to the State Department of Public Health or to the State University. The source of supply of drinking water should be selected with the greatest care and kept free from pollution. Often the clearest water is dangerous to life and health because of the disease germs it contains. (See Teacher's Guide, *Personal and Community Hygiene.*)

12. Food Values. In determining the value of any foodstuff, several items must be considered, such as the amount of heat it produces; the amount of nutriment it contains; its digestibility, and the facility with which it can be absorbed. If these requisites were known for each article of food purchased, the housewife would often make different selections and in so doing improve the diet, at the same time reducing the expense of her household. As an illustration of this let us note that the most expensive cuts of meat, as the tenderloin and sirloin in beef, contain less nutriment than some of the cheaper cuts, as the breast and flank. When these latter are properly cooked, therefore, they furnish more nutriment at less expense. Again, coarse breads are better foods for children and those leading sedentary lives than bread made from the finest white flour.

In general, vegetable food contains more nutriment for the system as a whole than meat. The latter, however, furnishes its nutriment in a more concentrated form and is more stimulating, so that a well-balanced menu should contain both animal and vegetable foods, with a preponderance of the latter.

COOKING

13. Purposes. Fruits, nuts, honey, some oils and a few vegetables, as the tomato and the melons, are valuable for food in their raw state, but most of the foodstuffs are far more digestible and nutritious when cooked; therefore, one of the chief purposes of cooking is to change the conditions of food so that the digestive juices can act upon it more readily. A second purpose is to make the food more appetizing by improving its flavor or appearance, or both. The appetizing influence of proper cooking and serving is never overlooked by the good cook in the home or by the *chef* in the hotel or restaurant. A third and very important purpose is to kill any germs, parasites or other organisms contained in the food which might otherwise produce disease, such as trichinosis, from eating raw ham, and typhoid fever, from drinking water contaminated by organic impurities.

14. Applications. Keeping in mind the facts, principles and purposes discussed in the previous pages, the teacher should give her class such lessons as will enable them to put these into practice. In general, lessons in cooking should be confined to the older girls, seldom including those below the sixth grade, and when the class includes girls of various ages and attainments the teacher may find it necessary to provide one set of exercises for the older girls and another for the younger. Be this as it may, all should receive such instruction and training as will make them conversant with those underlying facts and principles necessary to success in all cooking. The following sections indicate lines of work which are useful and practical and which can be carried on with success in any school where domestic science can be introduced. Each suggestion should be elaborated by the teacher as the capacity of her class and the time and conveniences may indicate. So far as possible, pupils should use the same material as most of them will use in cooking at home; whenever stoves or ranges are provided, these should be adapted to the kind of fuel in most general use in the community, whether it be wood, hard coal, soft coal or gas. The advantages and disadvantages of each kind of fuel and the cost of the same should be discussed with the class. Each pupil should make a study of the range in her home and be able to tell how to manage its dampers and checks. If she can draw a diagram of the range, showing the position of each damper and flue, and the directions which the currents of air take in passing through these, it will add much interest to the exercise.

15. Applications of Heat. All cooking is accomplished through the agency of heat. Heat is transmitted in three ways: by conduction, as when an iron rod is heated through its entire length by placing one end of it in the fire; by radiation, as when a room is warmed by a stove and the earth by the sun; by convection, as when heat is transmitted by the movement of a fluid in a vessel, such as water or air. All three methods of transmission are used in cooking. Roasting and baking, for instance, employ radiation; in boiling, convection is used, and in nearly all cases heat is transmitted by conduction from the surface to the interior of the article to be cooked.

Heat may be used directly, as in broiling and roasting, or indirectly, as when it is transmitted through a liquid. Whatever the method of transmission, the temperature should never exceed the point necessary to cook the article. For instance, eggs are cooked at 180° Fahrenheit. A temperature of 212°, that of boiling water, is not only unnecessary but injurious. Many articles of food are injured, if not spoiled, by being cooked at too high a temperature; as eggs, cheese, meat, milk and all proteins.

16. Equipment. Teachers of cooking often feel themselves handicapped because of lack of equipment. Such a situation may be met by one of three methods, which may be summarized as follows:

1. The Observation or Demonstration Method. This method requires only equipment enough for giving demonstration work in cooking before the class.

2. The Home Project Method. This method requires practically no equipment in the school but necessitates great skill on the part of the teacher, who must direct and plan the work so that the child becomes interested enough in the work at school to apply at home what she has learned.

3. The Laboratory Method. This is most satisfactory, but it requires space and equipment for each pupil to do individual work.

(a) INDIVIDUAL EQUIPMENT

1 small platter
1 mixing bowl
2 white bowls (one smaller than the other)
2 small brown white-lined baking or custard bowls
1 saucer
1 "soiled-dish" pan
1 soap shaker
1 baking dish with lid
1 measuring cup, measuring half and third
1 vegetable brush
2 salt and pepper shakers
1 biscuit cutter
1 egg beater
1 small frying pan
1 spatula; 1 case knife; 1 vegetable knife; 1 fork;
1 tablespoon; 1 teaspoon; 1 sieve
2 sauce pans with lids (one smaller than the other)
1 small pie tin (4 inches in diameter)
1 small cake tin (layer)
1 small cake tin (loaf)
1 dish pan
1 rinsing pan
3 towels for each worker (1 dish towel, 1 dish cloth and 1 hand towel 27 x 27") (See illustration, page 498.)

(b) LARGER EQUIPMENT FOR CLASS ROOM WORK

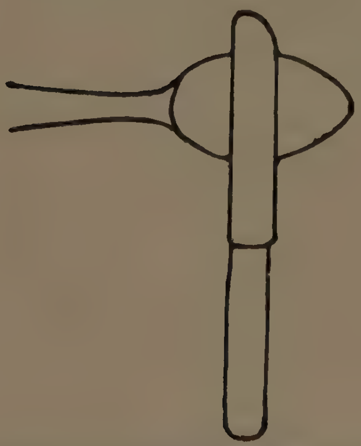
1 large teakettle
3 muffin pans (8 or 9 holes)
1 Universal Food Chopper
1 steel skillet
1 large double boiler
1 large saucepan with lid
1 can opener; 1 cork screw
1 large bucket
4 large pitchers
1 wire frying basket
1 frying kettle
1 sink strainer
1 garbage pail
1 flour sieve
1 lemon squeezer (glass)
1 large cake pan (loaf)
2 large cake pans (layer)

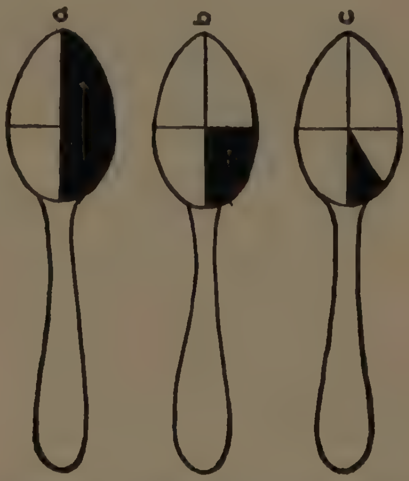
2 butcher knives
1 large coffee pot
1 grater; 1 funnel; 1 kitchen scales; 1 steamer
1 range or oil stove with oven

(c) Added Equipment when Possible

1 fireless cooker
1 dining table (plain)
6 dining chairs
1 small serving table on wheels
6 glasses
1 dozen teaspoons (plated)
½ dozen tablespoons (plated)
½ dozen forks (plated)
½ dozen knives (plated)
1 carving knife and fork
1 dozen napkins
1 table cloth
1 set of plain Austrian China dishes

17. Exact Knowledge. (a) Measurements. The study of foods, as a science demands exact knowledge. Correct weights and measures are absolutely necessary to insure successful results. Application of scientific methods saves much waste of time, labor, and material, and requires patience. All measures of dry material should be exactly level, while the measure of liquid is all the cup or spoon will hold. Fill the


CORRECT METHOD OF MAKING LEVEL MEASURE



CORRECT METHOD OF DIVIDING SPOON INTO HALVES, QUARTERS, AND EIGHTS cup or spoon heaping full, then with a spatula or straight-edged knife held across the top, level the measure. Hold the measure in the left hand, spatula in the right. Note illustration.

(b) Heat Units. Food is taken into the body for the purpose of building tissue and yielding heat and energy. The heat given off by the body is called fuel value. Energy is the ability to do work. Since heat is energy the fuel value of food, shows in part its nutritive value. If the quantity of heat produced by the food is measured, the measure indicates the quantity of energy the food is capable of giving the body.

The measures or heat units are called calories, which is a definite quantity of heat, or enough heat to raise 1 pint or 2 cups of water about 4° Fahrenheit, as raising the temperature of this water from 70° to 74° F, or the energy necessary to raise one pound 3,087 feet into the air (or 1 ton about $1\frac{1}{2}$ ft.) It is not practical for the teacher to try to estimate each food, for this belongs to the Science laboratory; but she can obtain free from the Department of Agriculture, Washington, D. C., the Farmers Bulletin No. 142, entitled "Principles of Nutrition and Nutritive Value of Food," which contains tables of the staple foods worked out giving the fuel value of each. If one then gets the habit of thinking in terms of 100 C. units, it becomes practical and easily estimated. To illustrate: 1 good sized egg equals 100 calories, slice of baker's bread $\frac{1}{2}$-inch thick equals 100 C., 1 inch cube of yellow cheese equals 100 C., piece of beef steak 3 x 4 and $\frac{1}{4}$ in. thick equals 100 C., 1 level tablespoon butter equals 100 C., etc. Refer to Plate illustrating 100 C. portions. (See illustration on page 498.)

(c) Tables. Much time and labor may be saved by adopting tables and learning equivalents as illustrated below.

Abbreviations

t.	teaspoonful
tb	tablespoonful
f.g.	few grains
c.	cupful
hp	heaping
sc	scant
pt	pint
qt	quart
oz	ounce
lb	pound
min	minute
hr	hour

Weights and Measures

3 t.	1 tablespoonful	2⅔c. powdered or brown sugar	1 pound
12 tb. (liquid)	1 cupful	9 to 10 eggs	1 pound
16 tb. (dry)	1 cupful	2 tb. butter or lard	1 ounce
2c.	1 pint	4 tb. flour	1 ounce
2 pt.	1 quart	3 tb. lemon juice	1 lemon
4 qt.	1 gallon	3 tb. egg	1 egg
2c. sugar	1 pound	2 tb. white & 1 tb. yolk	1 egg
4c. (about) flour	1 pound		

Calorie Portion of Common Foods

(Weight in Ounces)

1. Chocolate Candy	0.5	14. Lemons	8.
2. American Cheese	0.8	15. Beef	1.3
3. Sweet Chocolate	0.6	16. Macaroni (4 sticks, uncooked)	1.
4. Crackers	0.9	17. Eggs	2.4
5. Carrots	10.	18. Butter (1 tablespoon)	0.5
6. Potato	5.	19. Figs	1.1
7. Tomatoes	15.	20. Stick Candy	0.7
8. Wheat (puffed)	1.	21. Banana	3.6
9. Peanuts	0.6	22. Graham Bread	1.3
10. Rice	1.	23. White Bread	1.3
11. Oatmeal	1.	24. Onions	8.
12. Beans	2.8		
13. Cabbage	13.		

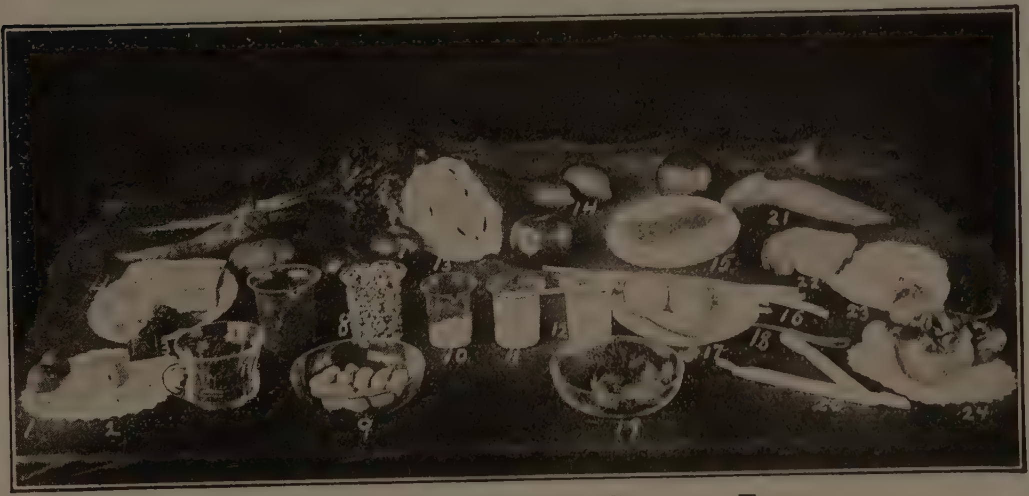
Iron-Giving Foods

1. Spinach
2. Strawberries
3. Beef
4. Apple
5. Potato
6. Peas
7. White Beans
8. Carrots

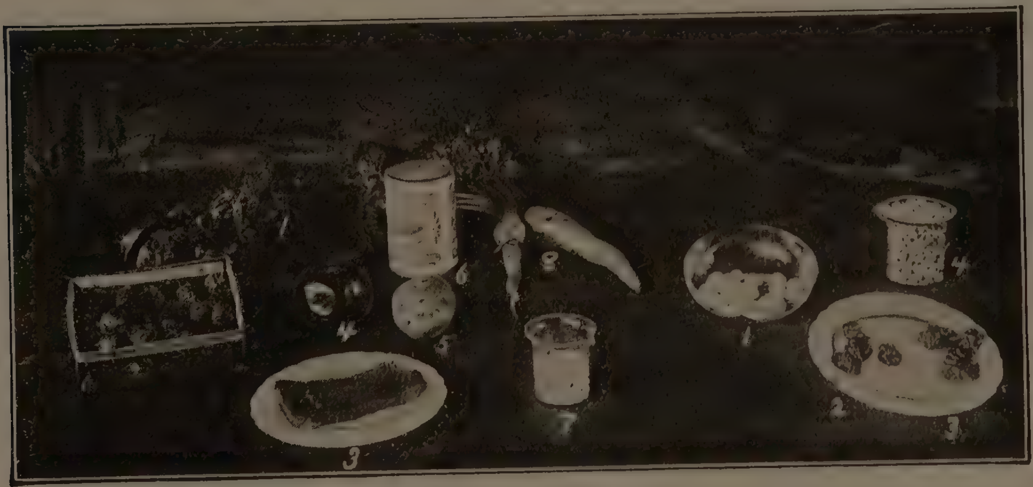
18. Choice of Methods. Two sorts of work in cooking may be done: (1) An experimental study of foods may be followed up by practice work in the home, along the lines of study taken up in the school. (2) Demonstration and practice work in cooking. The former can be done in any rural school if the teacher will work out the problems for herself, but practice work in cooking cannot be done successfully unless a separate room can be fitted up for the work.

The fundamental principle to keep in mind is the saving of time, labor, *energy* and material. In order to accomplish

INDIVIDUAL EQUIPMENT



100 CALORIE PORTION OF COMMON FOODS



IRON-GIVING FOODS

this, system, neatness and accuracy must be constantly practiced and emphasized. Begin with planning and placing equipment, having only necessary and useful utensils to work with. A simple and inexpensive equipment is shown in the illustration facing page 498.

19. Methods of Presentation. Methods of presentation will vary with the community, the size and membership of the class, the equipment, and the number of hours per week allotted to the teaching of cooking. In every lesson the teacher's ultimate aim should be to encourage the formation of habits of orderliness, cleanliness and accuracy in manipulating, and to teach helpfulness in the home so that the child may solve efficiently and economically the problems which homemakers in a particular community are called upon to solve.

COURSES OF STUDY

20. Plans. The following course of study is suggested for use in a rural school; it should be adapted by the individual teacher to meet her particular needs.

Recipes which will answer every purpose may be found in standard cook books.

Each month's work is planned on the basis of two two-hour periods per week. This includes written lesson, lecture, laboratory work or recitation. Outside work — home experiments, note-book work, and reference reading.

First Month

21. Lesson 1. The Kitchen. (a) Recitation. (1) Shape and size (10 x 12 ft. or not too large for home work).

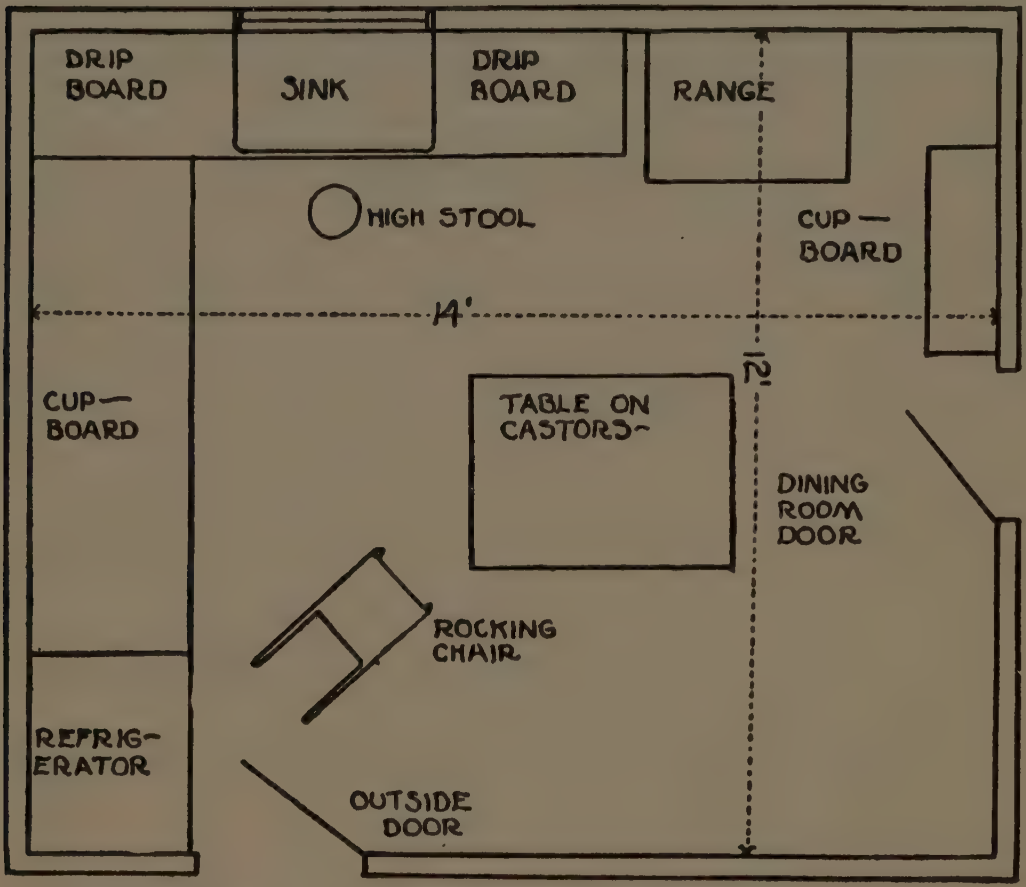
(2) Equipment, previously mentioned.

(3) Care of kitchen, cleanliness, order and placing of furniture to save time and steps.

(b) Laboratory Work or Activity. (1) List and care for articles in desk. In notebooks make a list of articles and draw order of keeping same.

(2) Clean and arrange cupboards. Remove equipment from cupboards, clean and replace.

(3) Care of sinks and supply table. If no sink, care of water brought in to and taken from the house. Teach how inexpensive force pumps can be placed in rural homes, showing that the expenditure of a few dollars is a great human saving. Farmers Bulletin No. 270, E. T. Wilson, obtained from Department of Agriculture, Washington, D. C.



CONVENIENT AND EFFICIENT KITCHEN

(4) Clean refrigerator; while cleaning, teach the placing of butter, eggs and meat on the lower shelf or cooler part, and vegetables and fruit above.

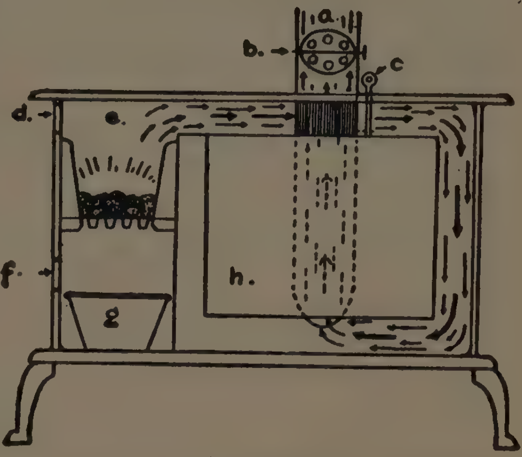
22. Lesson 2. Stove and Fuel. (a) RECITATION. (1) Kinds: liquids, as kerosene, gasoline, alcohol; solids, as wood, coal, etc. The story of the formation of natural fuels, for assigned work, adds interest.

(2) Value; relative costs in locality. Value as to cleanliness and labor.

(3) Essentials of combustion: fuel, oxygen of air and heat or kindling point.

(4) Products of combustion: water; smoke; carbon dioxide and other gases; heat.

(b) LABORATORY WORK. (1) Build the fire. Note the effect of drafts in the stove. If you have an illustrated catalogue showing the working of dampers in a cook stove, make use of it. (See also the accompanying illustration.)



COOK STOVE SHOWING USE OF DAMPERS

a. Pipe.
b. Damper in pipe.
c. Oven damper
d. Indirect check damper.
e. Fire box.
f. Direct damper.
g. Ash pan.
h. Oven.

23. Lesson 3. Water. (a) RECITATION. (1) Kinds and composition: hard and soft. Hard water contains more mineral and will not form a suds, but a greasy scum. Soft water forms suds.

(2) Uses as cleansing agent. Universally used for cleaning cloth, dishes, body, etc. Need of clean hands and person.

(3) Uses in body. It regulates the temperature of the body, dissolves the food, carries off waste and aids circulation.

(b) WATER TEST. (1) Purification: methods of making water pure, as boiling, filtering, addition of chemicals and distilling.

(2) Treatment of hard water. Boiling will soften hard water temporarily. Lime deposits can be observed in the teakettle. Discuss softening water by chemicals, such as lye, borax, washing soda, etc.

(c) LABORATORY WORK. (1) Determine temperature of water when small bubbles appear (185° F., called simmering point); when large bubbles appear and break on surface (212°F., or boiling point); when steam and vapor are given off. Notice as heat increases water boils more rapidly but does nor grow hotter. If no thermometer is at hand these facts may be told while the students observe. Teach freezing point (32°F.).

Add salt or sugar to water and notice it disappears, forming a solution. Add starch to cold water. Note that it becomes milky, but upon standing, settles to the bottom of the glass. This is called *suspension*. *Digestion* is changing a solid to a liquid or solution; hence foods easily going into solution are more quickly digested.

(2) Dish Washing. Use boiling soft water and plenty of soap. Scrape dishes. Order of washing: glasses; silver; china; cooking utensils. If kitchen is small, wash cooking utensils first. Rinse all in hot water. Place dishes in proper places. Hang towels to dry.

24. Lesson 4. Fruits. (a) RECITATION. (1) Use of various grades. Perfect fruit reserved to be used fresh, as eating apples, table fruits and vegetables. Imperfect fruit used for cooking.

(2) Comparison of values as food. Starchy fruits, as bananas; mineral fruits, as apples, oranges; sugar fruits, as grapes, dried fruits. Most fresh fruits contain 80 to 90 per cent water and considerable cellulose or woody fiber, and are used in the diet for bulk, minerals and the cooling effect of acids they contain.

(3) Preparation. Fresh, cooked, preserved or canned may be used.

(b) LABORATORY WORK. Prepare baked apples.

25. Lesson 5. Fruits (Continued). (a) RECITATION. (1) Decay. Spoiling fruits are full of bacteria and germs. Must be prepared with heat to destroy them, otherwise throw away decaying fruits.

(2) Methods of Preserving: with sugar, as canning and preserving; with salt, as olives; with vinegar, as pickled peaches; with chemicals, which are harmful, as canning powders; with spices, as spiced grapes.

(b) LABORATORY WORK. Prepare canned apples, pears, or plums by various methods described in standard cook books.

26. Lesson 6. Jelly-Making. (a) RECITATION. (1) Fruits most suitable for jelly, as shown by pectine test. Add two tablespoonfuls of alcohol to two tablespoons of fruit juice; if the mixture becomes thick, pectine, which determines the jelly-making properties of fruit juice, is present.

(2) Method of selecting and preparing fruit.

(b) LABORATORY WORK. Make apple, plum or grape jelly.

27. Lesson 7. Marmalade. (a) RECITATION. Sugar as a preservative.

(b) LABORATORY WORK. Prepare orange marmalade.

28. Lesson 8. Vinegar and Spices as Preservatives. (a) RECITATION. Methods of pickling; fruits and vegetables suitable for pickling.

(b) LABORATORY WORK. Prepare pickled peaches.

SECOND MONTH

29. Lesson 1. Carbohydrates. (a) RECITATION. (1) Definition and explanation of the term.

(2) Kinds of carbohydrates: sugar; starch; cellulose.

(3) Common foods containing carbohydrates.

(b) LABORATORY WORK. (1) Test for starch. Test a number of vegetables for starch by a drop of iodine, which turns starch a blue black — cereals, as rice, wheat, corn or any breakfast food. Try iodine on cornstarch; note the result.

(2) Study of starchy types of vegetables. *Potato Composition.* Experiment to find out what a potato contains. Grate a piece of raw potato. Place in a cheese cloth bag and wash it well in a bowl of cold water. Squeeze the cloth as dry as possible. Note the contents of the bag are cellulose, or woody fiber. Let the liquid in the bowl stand until a white sediment settles. Pour off the water carefully. (Note that the water is a red brown, due to the mineral washed from the potato.) Mix a small portion of water with the white residue, place in a saucepan and cook. Note that it resembles laundry starch. Test with iodine; it turns a blue black, which proves it to be starch.

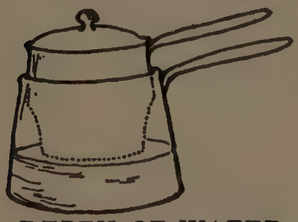
Baked Potatoes. The oven should be hot. Bake about one hour, turning once or twice. Test baked potato with iodine. (Turns lighter blue, showing starch is changed by heat.)

Boiled Potatoes. Test with iodine. It will be noticed that the boiled potato turns a darker blue than the baked. Note also that the baked potatoes are sweeter.

Why do doctors prescribe baked, and never boiled potatoes, and toast, instead of bread, for sick people? Starch is changed to dextrine, a form of sugar, and as sugar is more soluble it is more easily digested.

Test a slice of bread with iodine. Toast the bread and test again.

Place a teaspoon of flour in a pan. Heat slowly until very dark brown and uniform in color. Put a little in water. Note that it turns the water brown, or goes partly into solution. Test with iodine. (It turns a purple or grape juice color.) This is a test for dextrine, or starch turned to sugar. The baked potato is cooked at a higher temperature than the boiled, the toast at a higher temperature than the bread. Both taste sweeter, showing that starch is sweeter, or more nearly turned to sugar, at a high temperature than a low one. As sugar is more soluble than starch it becomes easier and quicker to digest. High temperature cooking of starch makes starchy foods sweeter and better flavored, as well as more quickly digested.



DEPTH OF WATER IN DOUBLE BOILER

30. Lesson 2. Starch as a Thickening Agent. (a) RECITATION. Sources of starch-cereals.

(b) LABORATORY WORK. Determine action of boiling water or milk on starch. Prepare creamed potatoes (white sauce).

31. Lesson 3. Cereals. (a) RECITATION. Definition of cereals; forms in which they are used as food.

(b) LABORATORY WORK. Prepare oatmeal and boiled rice, using double boiler.

32. Lesson 4. Vegetables. (a) RECITATION. (1) Classification of:

Cereals: wheat; oats; corn.
Pulse: peas; beans.
Roots and tubers: carrots; turnips; potatoes.

Green vegetables: cabbage; lettuce.

Fruits and nuts: apples; walnuts.

(2) Methods of Cooking. *Boiling.* Sugar and mineral go into solution, and unless the water in which they are cooked is used, much food value will be lost.

Baking. Food value retained.

Steaming. Food value retained.

Time for Cooking Vegetables

Asparagus	25 to 30 min.	Parsnips	30 to 45 min.
Beans	1 to 2 hours	Peas	20 to 60 min.
Beets	1 to 2 hours	Potatoes	20 to 30 min.
Cabbage	30 to 60 min.	Rice	30 to 45 min.
Carrots	1 hour	Salsify	45 to 60 min.
Cauliflower	20 to 30 min.	Squash	20 to 30 min.
Celery	2 hours	Spinach	15 to 20 min.
Corn	10 to 20 min.	Tomatoes	15 to 20 min.
Macaroni	20 to 50 min.	Turnips	30 to 45 min.
Onions	45 min.	Coffee	5 to 12 min.

(b) LABORATORY WORK. Prepare escalloped cabbage.

33. Lesson 5. Green Vegetables. (a) RECITATION. (1) Importance of vegetables in the diet.

(2) Storage of fruits and vegetables.

(3) General directions for preparing vegetables.

(b) LABORATORY WORK. Prepare stuffed tomatoes.

34. Lesson 6. Salads. (a) RECITATION. (1) Value of salads and salad dressings. Attractive way of using vegetables. Means of using left-overs. Dressings add oil or cream (fat) to the diet.

(2) Classification of Salads. From uncooked fruits and vegetables; from cooked vegetables; from meat, eggs, fish, etc.

(3) Rules for making and serving.

(4) Salad dressings: French; mayonnaise; cooked.

(b) LABORATORY WORK. Prepare potato salad with boiled dressing.

35. Lesson 7. Salads (Continued). (a) RECITATION. Discuss specific vegetables, where they grow, methods of growing. specific food values, cost, season, etc.

(b) LABORATORY WORK. Prepare several attractive salads — fruit, egg, salmon. Have different students make mayonnaise, boiled and French dressings.

36. Lesson 8. Dried Fruits. (a) RECITATION. Have a discussion of available dried fruits—apricots, prunes, peaches, apples and figs; their cost and food value as compared with fresh fruits.

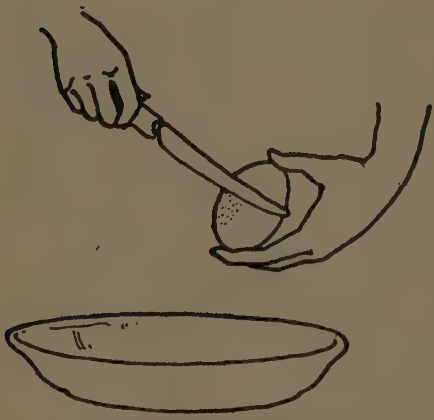
(b) LABORATORY WORK. Prepare stewed apricots.

THIRD MONTH

37. Lesson 1. Proteins (Eggs). (a) RECITATION. (1) Composition: white of egg, or albumen, a protein; yolk of egg, protein and some fat. Eggs also contain valuable mineral matter. Since they are lacking in carbohydrates it is best to serve them with bread, which furnishes starch, a carbohydrate.

(2) Food value as compared with other food.

(3) Structure: yolk and white.



CORRECT METHOD OF BREAKING EGG

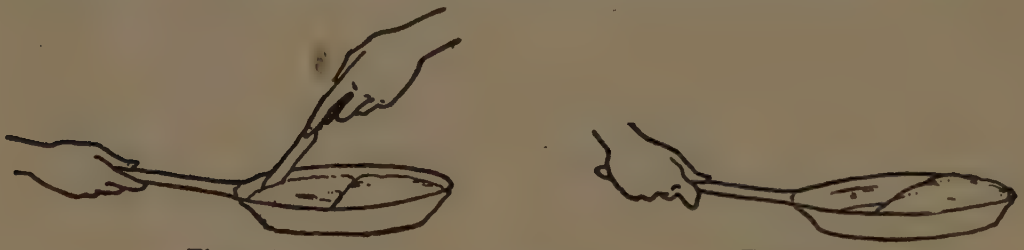


Figure 1 Figure 2

EGG OMELET

Figure 1. Cutting Omelet.
Figure 2. Folded Omelet.

(4) Effect of heat. Cook one egg in a saucepan in boiling water, 20 minutes. Cook another egg in water *below* the boiling point, 30 minutes. Note that the first is tough and rubbery; the second tender and jellylike, although both are hard. Notice also that the first has a darker coating around the yolk, which is mineral (sulphur), and is not as easily

taken care of by the body as it is when solidified, as in the second.

(5) Economy in use. Figure the price of eggs as compared with meat, cheese, nuts, etc.

(b) LABORATORY WORK. Prepare plain omelet; soft-boiled and hard-boiled eggs.

38. Lesson 2. Eggs as a Thickening Agent. (a) RECITATION. (1) Function of protein food: to build tissue.

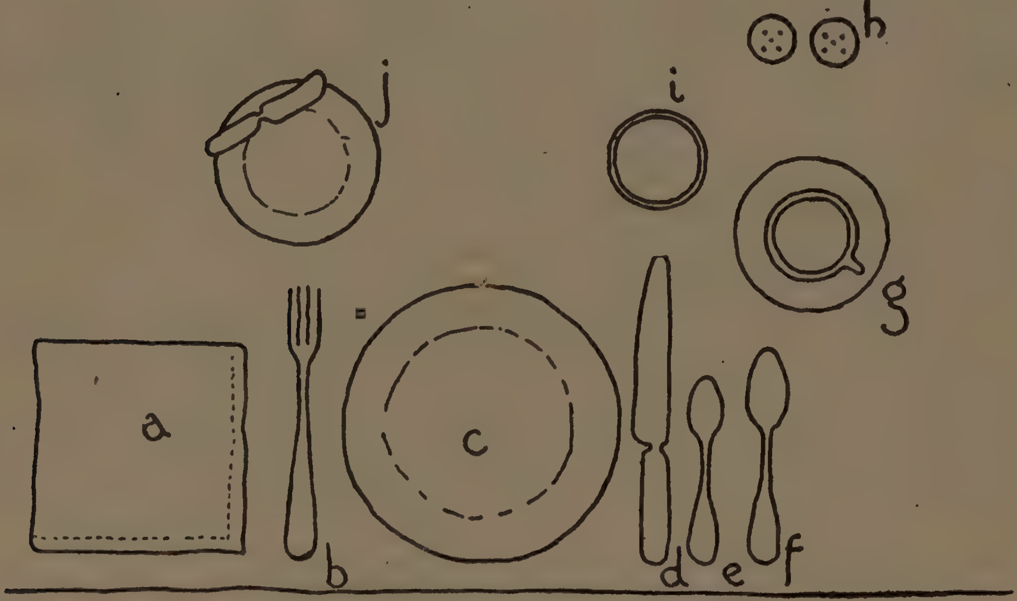
(2) Tests for freshness of eggs.

(b) LABORATORY WORK. Prepare baked custard.

39. Lesson 3. Beverages. (a) RECITATION. Production and use of coffee, tea and cocoa; their place in the diet.

(b) LABORATORY WORK. Prepare coffee, cocoa and tea; make buttered toast.

40. Lesson 4. Serving Breakfast (Review Lesson). (a) RECITATION. Correct method of setting the table and serving a meal.



SIMPLE METHOD OF TABLE-SETTING

(b) LABORATORY WORK. Serve a breakfast, using dishes already prepared in class.

41. Lesson 5. Cheese. (a) RECITATION. Discuss composition and preparation of common varieties of cheese, and its place in the diet.

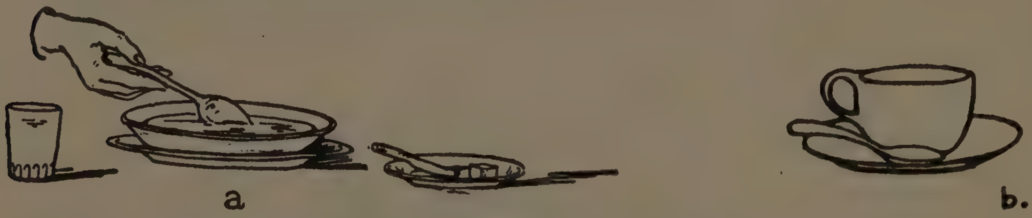
(b) LABORATORY WORK. Prepare macaroni and cheese.

42. Lesson 6. Milk. (a) RECITATION. (1) Composition of milk.

(2) Its importance as a food.

(3) Care of milk in the home.

(b) LABORATORY WORK. Prepare cottage cheese. Serve as a salad with French dressing.



(a) CORRECT METHOD OF USING SOUP SPOON.
(b) CORRECT METHOD OF PLACING SPOON IN SAUCER.

43. Lesson 7. Simple Invalid Cookery. (a) RECITATION. The uses of liquid diet for the sick and convalescent.

(b) LABORATORY WORK. Prepare egg-nog and cream of spinach soup.

44. Lesson 8. Prepare milk toast and cream of tomato soup.

FOURTH MONTH

45. Lesson 1. Meat. (a) RECITATION. (1) Structure of meat.

(2) Composition and importance in the diet.

(3) Cost.

(4) Common cuts.

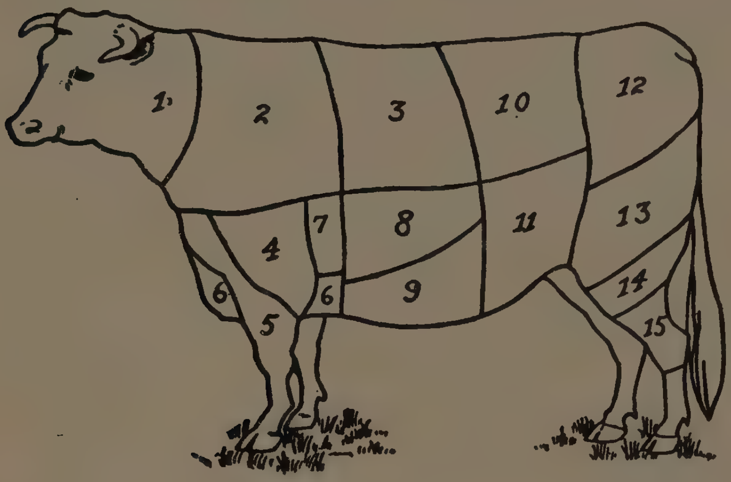
(b) LABORATORY WORK. Examine a piece of beef. Grind up and prepare meat balls. Serve with gravy.

46. Lesson 2. Beef. (a) RECITATION. (1) Characteristics of good beef.

(2) Comparative cost of various cuts.

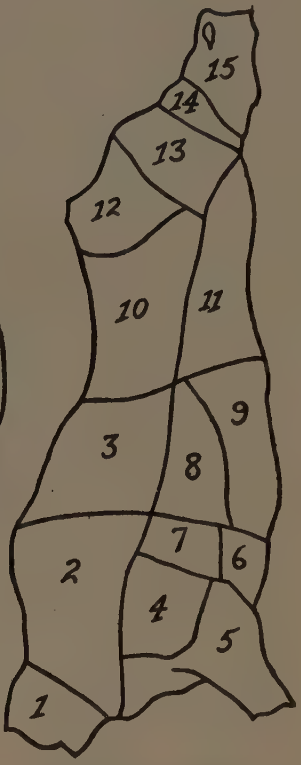
(b) LABORATORY WORK. Prepare stock soup with vegetables.

47. Lesson 3. Beef (Continued). (a) RECITATION. Study cuts (shown in the accompanying illustration); steaks; cutlets; roasting pieces; boiling and stewing pieces; organs used as food. Visit a meat market or farm when they are butchering and cutting up meat. Meat charts may be made by children from cuts. The tougher cuts contain more nutriment, but require a longer time for cooking.



CUTS OF BEEF

1. Neck
2. Chuck
3. Ribs
4. Shoulder clod
5. Fore shank
6. Brisket
7. Cross ribs
8. Plate
9. Navel
10. Loin
11. Flank
12. Rump
13. Round
14. Second cut round
15. Hind shank



SIDE OF BEEF SHOWING CUTS

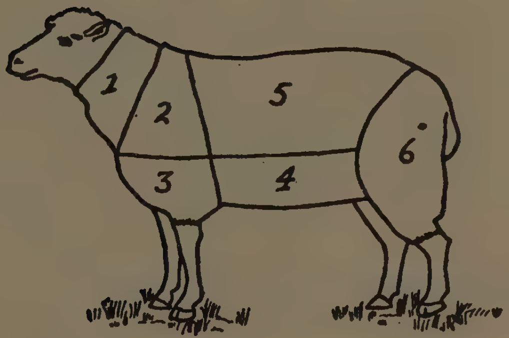
(b) Laboratory Work. Have the class prepare a rib roast of beef with browned potatoes.

48. Tables. Tables for length of time of boiling, frying and roasting meats, fish, etc., are found a great help and convenience, and make constant use of notes and recipe books unnecessary.

Table for Roasting Meats

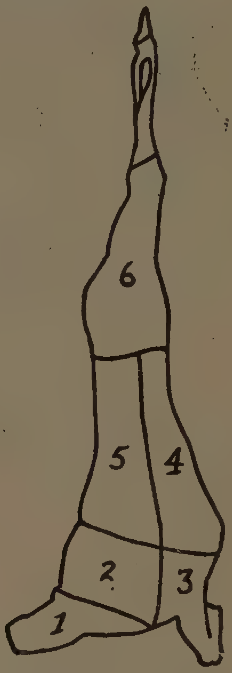
Beef	10 to 15 min. per pound, rare
Beef	15 to 20 min. per pound, well done
Beef (fillet)	20 to 30 min. per pound, rare
Veal	18 to 20 min. per pound
Mutton	15 to 25 min. per pound
Lamb	15 to 18 min. per pound
Pork	20 min. per pound

Chicken	15 or more min. per pound
Goose	2 hours or more for fowl
Duck	1 hour
Pigeons	2 hours
Whole Ham	4 to 6 hours
Fish	20 to 30 min. per pound



MUTTON

1. Neck
2. Chuck
3. Shoulder
4. Flank
5. Loin
6. Leg



CUTS OF MUTTON

Table for Broiling Meats

Steak, 1 in. thick	4 to 10 min.
Steak, 1½ in. thick	8 to 15 min.
Chops (except pork)	15 to 30 min.
Pork Chops	30 to 50 min.

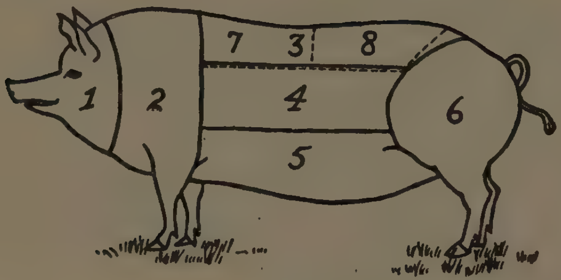
Table for Frying Meats

Small Fish	1 to 5 min.
Chops	5 to 8 min.
Muffins, fritters and doughnuts	5 to 8 min.

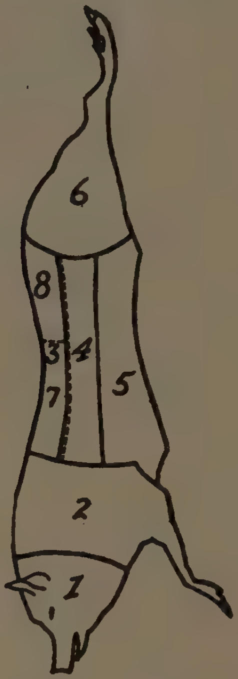
Table for Boiling Meat and Fish

Beef	4 to 6 hours
Corned Beef	5 to 8 hours
Tongue	2 to 4 hours
Ham	4 to 6 hours
Fish	10 to 20 min.
Braised Beef	3 to 5 hours
Chicken	1½ to 2 hours

49. Lesson 4. Pork. (a) Recitation. (1) Compare pork and beef.



PORK
1. Head
2. Shoulder
3. Back
4. Middle cut
5. Belly
6. Ham
7. Ribs
8. Loin



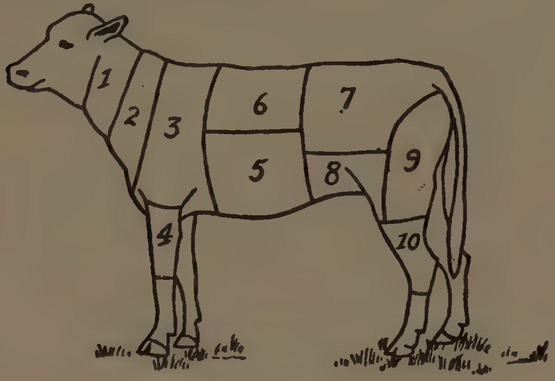
CUTS OF PORK

(2) Discuss various cuts.

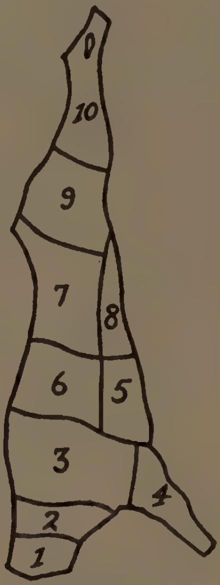
(3) Method of preserving (ham and bacon).

(4) Rendering of lard.

(b) Laboratory Work. Prepare breakfast of bacon and breaded pork chops.



VEAL
1. Neck
2. Chuck
3. Shoulder
4. Fore Shank
5. Breast
6. Ribs
7. Loin
8. Flank
9. Leg
10. Hind Shank



CUTS OF VEAL

50. Lesson 5. Veal. (a) Recitation. (1) Compare veal with other meats as to nutritive value, digestibility, etc.

(2) Discuss cuts, cost, etc.

(b) Laboratory Work. Prepare veal loaf.

51. Lesson 6. Review. Serve a luncheon, using dishes already prepared.

Suggested Menu

Cream of corn soup
Veal loaf, baked potatoes, stuffed tomatoes, tea
Fruit salad
Baked custard

52. Lesson 7. Candy. Have different members of the class make several kinds of candy — fondant, taffy, peanut brittle, fudge, penouche and butterscotch.

53. Lesson 8. Written Test. This test should be on the work done up to this time.

FIFTH MONTH

54. Lesson 1. Flour. (a) RECITATION. The composition and manufacture of flour; kinds of flour.

(b) LABORATORY WORK. Make baking-powder biscuits. Experiment with combinations of flour and liquid in the following proportions:

1 of flour to 1 of liquid for pour batters, as popovers.
2 of flour to 1 of liquid for drop batters, as muffins.
3 of flour to 1 of liquid for soft doughs, as biscuits.
4 of flour to 1 of liquid for stiff doughs, as bread.

55. Lesson 2. Leavening Agents. (a) RECITATION. Discuss the following leavening agents:

(1) Steam, as in popovers.

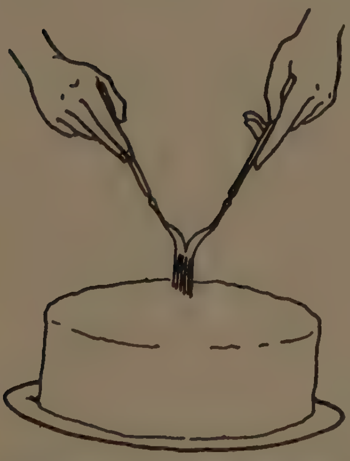
(2) Air in eggs, as in angel food cake.

(3) Baking powder, as in muffins.

(4) Soda and sour milk, as in sour milk biscuits.

(5) Yeast, as in yeast bread.

(b) LABORATORY WORK. Make sponge cake.



METHOD OF CUTTING SPONGE CAKE
USE FORKS ~ NEVER KNIVES ~

56. Lesson 3. Butter Cake. (a) RECITATION. Teach methods of mixing ingredients, and ways of varying recipe.

(b) Laboratory Work. Make plain butter cake with boiled icing. A good foundation is:

$\frac{1}{3}$ c. butter
1 c. sugar
2 eggs
$\frac{2}{3}$ c. milk
$1\frac{3}{4}$ c. flour
$2\frac{1}{2}$ t. baking powder
$\frac{1}{4}$ t. salt

Flavor may be 1 t. vanilla or lemon extract; $\frac{1}{2}$ t. almond extract; 2 t. spices, as nutmeg or cinnamon; $\frac{1}{2}$ c. citron, currants, raisins or nuts; grated rind of $\frac{1}{2}$ orange with vanilla, or 4 tb. cocoa with vanilla.

57. Lesson 4. Bread. (a) Recitation. (1) Yeast and its importance in bread-making.

(2) Various processes of bread-making.

(b) Laboratory Work. Make bread by quick-rising process.

58. Lesson 5. Bread (Continued). (a) Recitation. Discuss points brought up in previous lesson — mixing, rising and baking of bread, etc.

(b) Laboratory Work. Repeat bread lesson, making biscuits, Parkerhouse rolls, tea braids, etc.

59. Lesson 6. Cookies. (a) Recitation. Discuss proportions of flour and liquid in batters and doughs of varying consistencies.

(b) Laboratory Work. Make drop cookies, hermits and rolled cookies, ginger snaps, etc.

60. Lesson 7. Desserts. (a) Recitation. (1) Importance of dessert in diet.

(2) Use of different kinds of dessert.

(b) Laboratory Work. Have different portions of the class make bread, rice and tapioca puddings.

61. Lesson 8. Gelatin. (a) Recitation. Origin and properties of gelatin.

(b) Laboratory Work. Make fruit gelatin or snow pudding.

SIXTH MONTH

62. Lesson 1. Pastry. (a) Recitation. Method of manipulation in mixing ingredients.

(b) Laboratory Work. Make apple or some other kind of pie.

63. Lesson 2. Pastry (Continued). Make single crust pie with filling and crust cooked separately, as lemon cream pie.

64. Lesson 3. Pastry (Continued). Make single crust pie with filling cooked in the crust, as custard pie.

65. Lesson 4. Frozen Desserts. (a) Recitation. Effect of different proportions of ice and salt in freezing mixture on consistency of contents of freezer.

(b) Laboratory Work. Prepare orange ice.

66. Lesson 5. Frozen Desserts (Continued). Prepare vanilla ice cream.

67. Lesson 6. Give a reception or afternoon tea, serving cookies and ice or ice cream.

68. Lesson 7. Cornstarch Pudding. Make chocolate cornstarch pudding and plain cornstarch pudding with fruit sauce.

69. Lesson 8. Whips. Make prune and apricot whip.

Seventh Month

70. Lesson 1. Dinner. Serve a dinner, using dishes prepared in class.

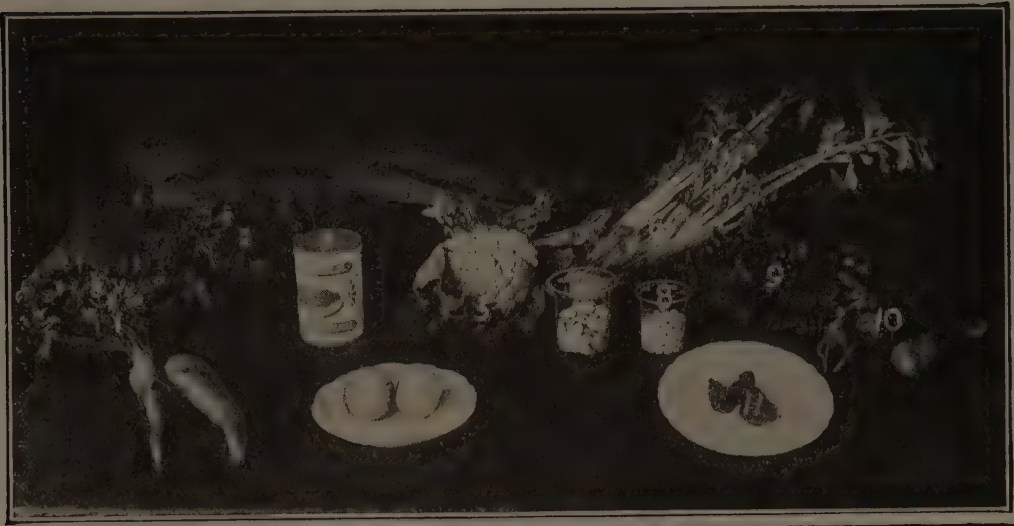
71. Lesson 2. Cleaning. Teach the care of materials commonly used in household equipment. Clean the cooking laboratory and all utensils.

72. Lesson 3. Planning Meals. Review classification of foods and the composition of the common food materials.

73. Lesson 4. Breakfast. Plan three breakfasts for a family of four, to cost twenty, thirty-five and fifty cents respectively. See that they are "balanced" meals.

Sodium-Giving Foods

1. Carrots
2. Spinach
3. Peas
4. Eggs
5. Cauliflower
6. Celery
7. Lentils
8. Peas
9. Lettuce
10. Beets
11. Prunes



Sodium-giving Foods
Magnesium-giving Foods
Model Kitchen

Magnesium-Giving Foods

1. Radishes
2. Carrots
3. Onions
4. Lettuce
5. Peas (Green)
6. Beans (String)
7. Cauliflower
8. Tomatoes
9. Beans (Dried)
10. Eggs
11. Figs
12. Celery
13. Chocolate
14. Turnips
15. Beets
16. Cabbage
17. Parsnips

Model Kitchen

1. "Soiled-dish" pan for knives, forks and all small utensils to keep soil from desk.
2. Measuring a cup of flour, taking level measure, making level by means of spatula.
3. Measuring $\frac{1}{2}$ tablespoon, cutting lengthwise of spoon.
4. Measuring $\frac{1}{4}$ tablespoon.
5. Measuring level tablespoon with spatula.
6. Scales for weights. 1 c sugar = $\frac{1}{2}$ lb.

74. Lesson 5. Dinner. Plan three dinners for a family of four, to cost forty, fifty and sixty cents, respectively.

BALANCED RATION FOR ONE DAY

Breakfast

Orange
Bacon
Puffed Rice
Rolls
Coffee

Luncheon

Creamed Salmon on Toast
Peas
Stewed Prunes
Bread
Milk or Cocoa

Dinner

Cream Soup (Carrot)
Roast Beef Mashed Potatoes
Spinach Cabbage Salad
Gelatine Dessert with Custard

75. Lesson 6. Bread Contest. Government Bulletin No. 112, *Bread and Bread-Making*, contains full directions for judging bread. It can be procured by writing the Department of Agriculture. In judging bread, the following points are considered:

1. The flavor is decided by odor and taste, and must yield the sweet nutty savor found in fresh wheat. Any sour, musty or yeasty suggestion compels a cut on the score. If fresh wheat is masticated, then bread, the flavor should be very much the same.
2. Lightness is determined by the weight of the loaf proportionate to the weight of material used. Should feel lighter than it looks.
3. Grain and texture are judged by the fineness and tenderness of crumb. Cells or grain of bread should be small and uniform in size. No large spaces.
4. Crumb should be cut on score as the color fails to reach the standard of creaminess; also as it approaches doughiness.
5. Moisture is determined by the elasticity of the loaf (if bread flies back when pressed with finger).
6. Crust should be cut on the score as it fails to show a yellowish brown color, correct depth of about three-sixteenths of an inch, and a crispy, crumbling texture.
7. Loaf should be cut on score if it is too large to give best points in the above.
8. Use pan $3\frac{1}{2}$ x $7\frac{1}{2}$ x 2 or 3, or as near as possible.

Bread Score Card

Flavor	20
Lightness	10
Grain and Texture	20
Crumb and Doughiness	20

Moisture	15
Color	5
Crust	5
Shape and size	5
Total	100

76. Lesson 7. Box Lunches. (a) RECITATION. (1) The contents of the lunch-box should be attractive and nutritious.

(2) The package should be compact, clean and of such a kind as to keep the food in palatable condition.

(b) LABORATORY WORK. Make several kinds of sandwiches.

77. Lesson 8. (a) THE LUNCH. Have each girl bring from home a lunch-box packed as she thinks it should be. Criticise each one as to appearance and contents, nutritive value, variety, cost, etc.

(b) PACKING THE LUNCH. Tin buckets, pasteboard boxes and baskets are the most common receptacles for the school lunch. All have their advantages and disadvantages. The bucket and pasteboard box prevent the drying out of the food, but on the other hand retain odors. Then again, it is impossible to sterilize the box and basket. Although the bucket may be sterilized, it is not done frequently enough. Good clean paper or wax paper seems to be best, or boxes that can be fresh and thrown away each day. This also does away with the necessity of carrying home baskets, buckets, etc. Plenty of paraffin paper should be used to wrap the food. This prevents drying out, mixing of foods and flavors, and makes the lunch attractive and clean. Paper cases for custards and semi-liquid foods are inexpensive and practical. Neatness is essential in packing. Wrap each food separately and place in receptacle in the order to be used; that on top which is to be eaten first, etc. Two plain white paper napkins should be on the top.

(c) SANDWICHES. As sandwiches are important articles of food for the school lunch, care should be taken in both making and selecting types of sandwiches. If quantities are to be made, slice the bread, melt the butter and put on the bread with a pastry brush (a small paint brush, about 2 inches across with white bristles, well washed, makes a good pastry brush). Bread should be twenty-fours old to cut well. Use a sharp knife for slicing bread. Cut slices thin and vary shapes and sizes, making round, square, triangle, crescent, oblong and fancy shapes by using fancy cutters. Variety can also be secured by using different breads, as white, whole wheat, graham, Boston brown, nut bread, etc. If sandwiches are prepared several hours before they are served, they may be kept fresh and moist by being wrapped in a damp cloth and kept in a cool place. Paraffin paper answers the same purpose, and provides a sanitary and water-proof covering. Two kinds of sandwiches should be in every lunch; sweet sandwiches and seasoned sandwiches.

For sweet sandwiches use dates or figs and nuts and sweet cream; fudge; jellies or jams and chopped nuts; preserved or dried fruits; bananas and lemon juice; nuts; brown bread with prunes, nuts and lemon juice.

Seasoned sandwiches may be filled with chopped egg, chicken, veal, celery, olives, or olives and nuts with salad dressing; salted meats; sliced meats (cut cross grain); meats chopped with a little mustard; Worchestershire or horseradish sauce with beef or tongue; caper, catsup, mint or tomato sauce with lamb or mutton; chopped sweet peppers, celery salt, parsley or lemon juice with fish. Any number of left overs may be used for variety and combination. Do not neglect the fat in the child's lunch, but be sure it is appetizing, pleasing and easy of digestion.

(d) RELISHES. Radishes, celery, salted nuts, olives and pickles.

(e) DESSERTS. Plain cakes, cookies, gingerbread, cream puffs, custards, fruit, candies, etc. Pickles are of doubtful value for children.

During the noon hour teach courtesy and table manners; take plenty of time for eating and masticating food. Have good fresh air in the room for it is unhealthful to sit in a place not properly ventilated.

SCHOOL AND HOME

78. Home Work. There are many ways in which the rural school teacher may correlate domestic science with the home life of her pupils as well as with other subjects in school. A study of the commoner food materials can be made in the geography course; calculations of cost of meals and articles of food make excellent problems for arithmetic.

79. Domestic Science Contests. Much interest has been aroused throughout the middle western states in domestic science contests where exhibits of work done by the children in foods and sewing are entered for prizes, or simply to educate and encourage good standards. It is not uncommon for boys to take prizes in cakes, breads, etc. The teachers here have the opportunity to establish standards by means of score cards, and to teach that it is not enough to know good bread or cake, but that one should know when and how to serve each of the various foods to produce the best results in the body, and that the body should be nourished in a way to promote health and efficiency. If these exhibits and contests are held with the Agriculture and Corn shows, it can be shown that the balanced feeding of man is based upon the same principles as the rational feeding of animals; in each the best results in the way of health, amount of labor performed and economy are secured when the body receives nutriment sufficient for the production of heat and energy and for the repair of worn-out tissue. Standard score cards for various foods commonly exhibited follow:

Butter Score Card

Flavor	45
Body	25
Color	15
Salt	10
Package	5
Total	100

Flavor: Butter should not taste strong or rancid or musty. It should not contain absorbed flavors, nor be flat or too salty. Should have a pleasing, slightly acid flavor of ripened cream.

Body: Cut sample through middle. Edges should be firm, no jets of moisture, color uniform and not streaked. Should be waxy, not greasy.

Salt: Just enough to prevent flat taste. None should show on the butter.

Package: Firm, smooth block wrapped in oil paper.

Color: Deep cream color, uniform and not streaked if artificial color is used.

Candy Score Card

Attractiveness (shape and size)	25
Color	10
Size of Crystal (creamy consistency)	25
Flavor	25
Packing in box	15
Total	100

Cake Score Card

Flavor	30
Lightness	20
Grain and Texture	15
Baking	15
Shape and size	10
Appearance (icing)	10
Total	100

Canned Goods

Canned fruits will be divided into small fruits, as strawberries and raspberries, and large fruits, as peaches and apples.

Vegetables will be divided into classes, as green vegetables and colored.

1. All canned goods must be in glass cans.
2. Size of can to be not less than one pint.
3. Canned goods will be judged as to flavor, appearance, color, and selection of fruit or vegetable.

Canned Fruit Score Card

Fruit	
Perfection of Fruit	15
Color	15

Flavor	30
Syrup	
Flavor	15
Color and Clearness	15
Proportion of Fruit to Juice	10
Total	100

Canned Vegetable Score Card

Perfection of Vegetable	25
Color and General Appearance	20
Flavor	35
Suitable Method of Preservation	20
Total	100

The fruit or vegetable should approach as nearly as possible natural colors and flavors, and generally retain their shape.

Marmalade and Jelly Score Card

Homogeneity	15
Consistency	25
Clearness of juice	20
Flavor	25
Color	15
Total	100

80. Canning Clubs. The canning clubs, under the direction of the government, do much to create interest in domestic science work; and other agencies, such as the Camp Fire Girls, which add a touch of romance to household duties, can be used to great advantage by the teacher in rural communities.

The above outline for a cooking course in a rural school is, of course, only suggestive. It depends upon the teacher herself and upon the ability of the pupils whether they shall do more or less work than what is given. With the government bulletins, which are hers for the asking, and the innumerable reference books available on the subject of food and its preparation, no teacher will have difficulty in planning and executing a course of study which shall exactly meet the needs of the community which she is endeavoring to serve.

81. Bibliography. (For the domestic science teacher.)

Boston Cooking-school Cook-book. Fannie M. Farmer.

Homemaker Series. Olive Green.
Practical Cooking and Serving. J. M. Hill.
Source, Chemistry and Use of Food Products. Bailey.
Principles of Cooking. Emma Conley.

Bulletin No. 39, Part IV, 1914, U. S. Bureau of Education, on *Education for the Home*, by Dr. B. R. Andrews, of Columbia University, gives a complete list of references on education for the home. The bulletin will be sent on receipt of ten cents. A list of government bulletins on all subjects pertaining to home economics is published monthly by the Bureau of Publication, Washington, D. C., and will be sent free upon request.

SEWING

82. General Suggestions. (1) Sewing can be begun in the Kindergarten, and boys as well as girls will take an interest in it up to the fifth grade if proper projects are selected. Since it is a convenience, if not a necessity, for everyone to be able to sew, this art should be taught in all grades of the public schools, and in grades below the fifth it should be required of all the pupils.

(2) Teach the pupils hand stitches, emphasizing neatness.

(3) Have the exercises based upon something useful, If the pupils make a bag, for instance, see that the bag has some utility and that the pupils know why it is made.

(4) Study relative values. Don't spend hours putting hand stitches and embroidery on a dark cook apron.

(5) Discuss the selection of material with the pupils. Lead them to see that the selection should be determined by the use to which the article made from it is to be put, the weave, fitness of color, durability and cost. If an article of clothing is under consideration, the appropriateness of the fabric and color to the individual are the points to be emphasized.

The selection of material for clothing and for napery and bedding, constitutes an important problem in every household, and the teacher should give this matter careful consideration.

83. Study of Textiles. Pupils should be taught how to distinguish the different fibers which enter into the manufacture of textiles. These are cotton, wool, linen or flax, and silk. Study the growth of each of these fibers, its preparation for market, the process of manufacture and the most common fabrics made from each. The study of the great inventions — the cotton gin, the power loom and the spinning frame — which have revolutionized the textile industry of the world, will be of great interest to the older pupils.

84. Nature of the Work. With younger children articles to be made should not be too large, as interest will lag if too much time is spent upon one thing. The doll project has proven a splendid problem for many grades. For the fifth grade, if it is dressed as a baby, begin with the band, teaching why it should not be hemmed, pinned or buttoned, following with the other garments in the order of baby clothing. The child learns many points of mother-craft without any feeling of embarrassment, and intense interest is shown. It is a revelation to many to know of the Gertrude suits, why even safety pins should not be used on the doll or baby, the proper length of clothing and the many points of hygiene that lead to both the comfort of the child and its attendant.

Hand work, as crocheting, knitting and tatting, may be taught, but care should be taken in the selection of good designs. Teach that time is too precious to spend much on this class of work, when so many things in the world much more worth while are left undone. These forms of work are simply for pick-up work, or for the invalid or for the elderly person when physical conditions prevent them doing more important things. It fills their time and minds with something of interest to do, and will prevent many a person from feeling worthless or brooding over seeming troubles.

As a rule commercial patterns are more practical, but if time permits a few simple patterns may be drafted for the purpose of the study of line and the understanding of pattern making. Laces, embroideries and other decorations can be studied. Many garments are ruined by misplaced ornamentations.

85. General Rules. Emphasize neatness, system and accuracy from the beginning, starting with the following simple rules. If given as a drill the entire class will work together and shorten the time, overcoming many future difficulties.

(1) Clean hands are necessary.

(2) Sit straight, well back in chair, feet flat on floor and light from the left shoulder or above.

(3) Be sure the chair is not too high.

(4) Do not fasten or pin work to the knee.

(5) Measure thread from hand to shoulder, or shoulder to shoulder, or place elbows at waist, then as far as raised hands will extend (keeping elbows close to sides). If thread is too long it soils, knots and wears out.

(6) Never bite, always break or cut thread.

(7) Thread needle from end of thread that first comes from the spool.

(8) Do not put thread, needle or pins in the mouth.

(9) Always trim selvage from material.

(10) The finger should never touch the end of the thimble, always allow room in the thimble for air space.

(11) Always cut with the sharper point of the scissors under the material and the round point on top.

(12) Always use tape beginning with the second inch as the first inch is not always accurate. Use the unsewed side of the tape.

(13) Use No. 10 needle with thread Nos. 100-90-80.
Use No. 9 needle with thread Nos. 90-80-70-60.
Use No. 8 needle with thread Nos. 70-60-50-40.
Use No. 7 needle with thread Nos. 50-40-30-20.
Use No. 6 needle with thread Nos. 20-10
Use No. 5 needle with linen and heavier threads.

86. Equipment. Very simple equipment is sufficient for each child.

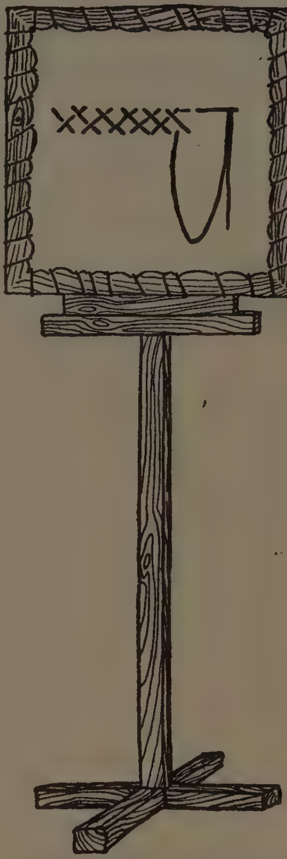
Sewing Box. (This may be a collar box given away by any dealer carrying linen collars.) Place child's name on the box.

Pin cushion; thimble; needles (1 paper Nos. 5-10 Sharps and a few embroidery needles).

Scissors; thread; tape.

A few yardsticks should be kept for class use. Fewer scissors are possible, but better work and more development is obtained if each child is responsible for his own utensils.

87. Stitches. Stitches should be carefully taught as to method of making, use and fitness of each. Insist that the wrong side of the stitch is correct, as well as the right side. Always call stitches by their names as:



DEMONSTRATION FRAME

- Running Stitch.
  - Regular running stitch.
  - Space and stitch equal.
  - Irregular running stitch.
  - Space and stitch unequal — used for basting and gathering, so sometimes called basting stitch or gathering stitch.
- Two Running and Back Stitching.
  - Right side.
  - Wrong side.
- Running and Back Stitching.
  - Right side.
  - Wrong side.
- Back Stitching.
  - Right side.
  - Wrong side.
- Stitching Back Stitch (looks like machine work on right side).
  - Right side.
  - Wrong side.
- Hemming Stitch (known as tent shape stitch).
- Overcasting.
  - Also same stitch to prevent fraying of raw edges.
- Overhanding.
  - (Same stitch as overcasting, but closer together, therefore straighter. Used for French hems, whipping materials together, sewing on lace, etc.)
- Button Hole Stitch.
- Blanket Stitch.
- Herringbone Stitch.
- Feather or Brier Stitch.
- Darning Stitch.
  - Weaving.
  - Simple over one, under one.

With the mastery of the above stitches and their application all stitches may be built;— then darning, patching, gussets, plackets, sewing on of tape, may be taught by selection of projects. Never, under any consideration, teach models or patches, but always teach the stitch on some article or garment which will answer the three tests: Is it useful? Is it desirable? Is it artistic and appropriate to its use?

88. Work by Grades. The work of the first four grades should be on coarse material, stitches large and simple, and the projects selected fitted to the play of the child but with some value. The boys as well as the girls enjoy sewing through this period. Always give children a margin of choice with material, color, design, shape and size of article, to develop creative ability. It is true, however, that the teacher must direct.

(a) FIRST GRADE. Material. Java canvas, canvas, burlap, coarse swiss, muslin and flour sacking.

Stitches. Running, cross stitch.

Projects suggested. Doll's bed clothing. Tack mattress and comforts. Make needle books, napkin rings, rugs and mats for doll house, bags, table mats, dust cloths, etc.

(b) SECOND GRADE. Stitches. Running, gathering, cross stitch, catch stitch and blanket stitch.

Projects suggested. Table covers, stenciled; table covers, cross stitch; dish towels, doll's bedding, blanket stitch around outing flannel blankets and curtains, mats, etc., for doll house; Indian clothing; flags of nations; weather bags for foods, clothespins, handkerchiefs, etc., bead work.

(c) THIRD GRADE. Stitches. Hemming, turning, basting, sewing, mitering corners, over seaming, over casting, backstitching. Practice mitering corners on paper.

Projects suggested. Wash cloths of white outing flannel, cheese cloth, etc.; baseball, marble and jack bags; button bags; flags; book covers; sunbonnets; pillows; mark towels; handkerchiefs, etc.; sails for boats; doilies; centerpieces; towels; napkins; sewing bags; pillow slips, etc.

(d) FOURTH GRADE. In addition to stitches of previous grades — French seams. flat felled seams, patching.

Simple patterns, as kimono for doll.

Projects suggested. Simple aprons for sewing or work; bags for books; tents, traycloths; dust cloths; dust caps; pin cushions; table covers, plain or ornamented with cross stitch, catch stitch, feather stitch, darning stitch, plain regular running stitch or chain stitch, or stenciled design; doll clothes, cut and make.

(e) FIFTH GRADE. Stitches should grow smaller and neater, material finer and much neater work demanded. Sew on buttons, make button holes, also introduce some crocheting.

Projects suggested. Collar and cuffs sets to freshen school dresses; guest towels; pillow cases; sheets; pin cushions; dresser scarfs; school banners; badges; middy blouses; outing flannel gowns or muslin gowns; cooking aprons; hand towels; hot dish holders, etc.

(f) SIXTH GRADE. Plackets, gussets, bias seams, hemstitching, knitting.

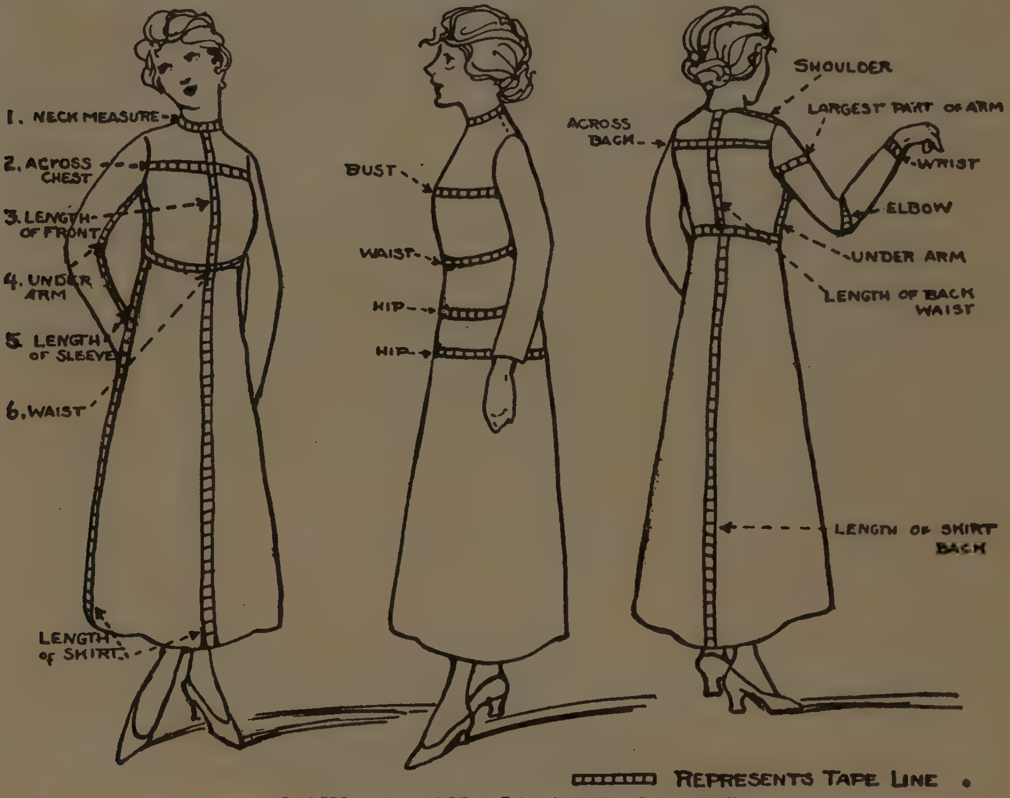
Projects suggested. Drawers; skirts; teddy-bears; afternoon embroidered aprons; kimonos; bungalow aprons; handkerchiefs; crochet or knit caps; scarfs; shawls; tam'o'shanters; heelless bed socks; etc. The care of the clothing with repair of same should be emphasized.

(g) SEVENTH GRADE. Tatting and embroidery stitches as well as all previous mentioned stitches should be used, of course not on one project.

Projects suggested. Undergarments; napkins; repairing and patching silk and wool; re-binding skirts. Study textiles and laces in a simple manner. Articles such as curtains, bed spreads, tea sets, etc. for girl's own room, and simple waists, may be made.

(h) EIGHTH GRADE. Making over, ripping, cleaning, dyeing, and renovating dresses; make eighth grade graduating dress and under garments; summer blouses and simple dresses.

(i) SUGGESTION. Many of the projects suggested may be made to fit in other grades, depending upon the age of the child, and previous training. The financial side must always be considered and some things fitting to one locality will not fit into another. Unbleached muslin, known as domestic cloth, lends itself beautifully to curtains, tea sets, bed room sets, etc. Sugar and flour sacks make beautiful and durable rompers, aprons and even dresses if trimmed in bias strips of checked, striped or polka dotted calicoes, ginghams, etc. Discuss such problems as home made vs. ready made garments; Does it pay to darn and patch? Division of income spent for clothing and keep a note book with pictures and costs of all wearing apparel purchased in school year.

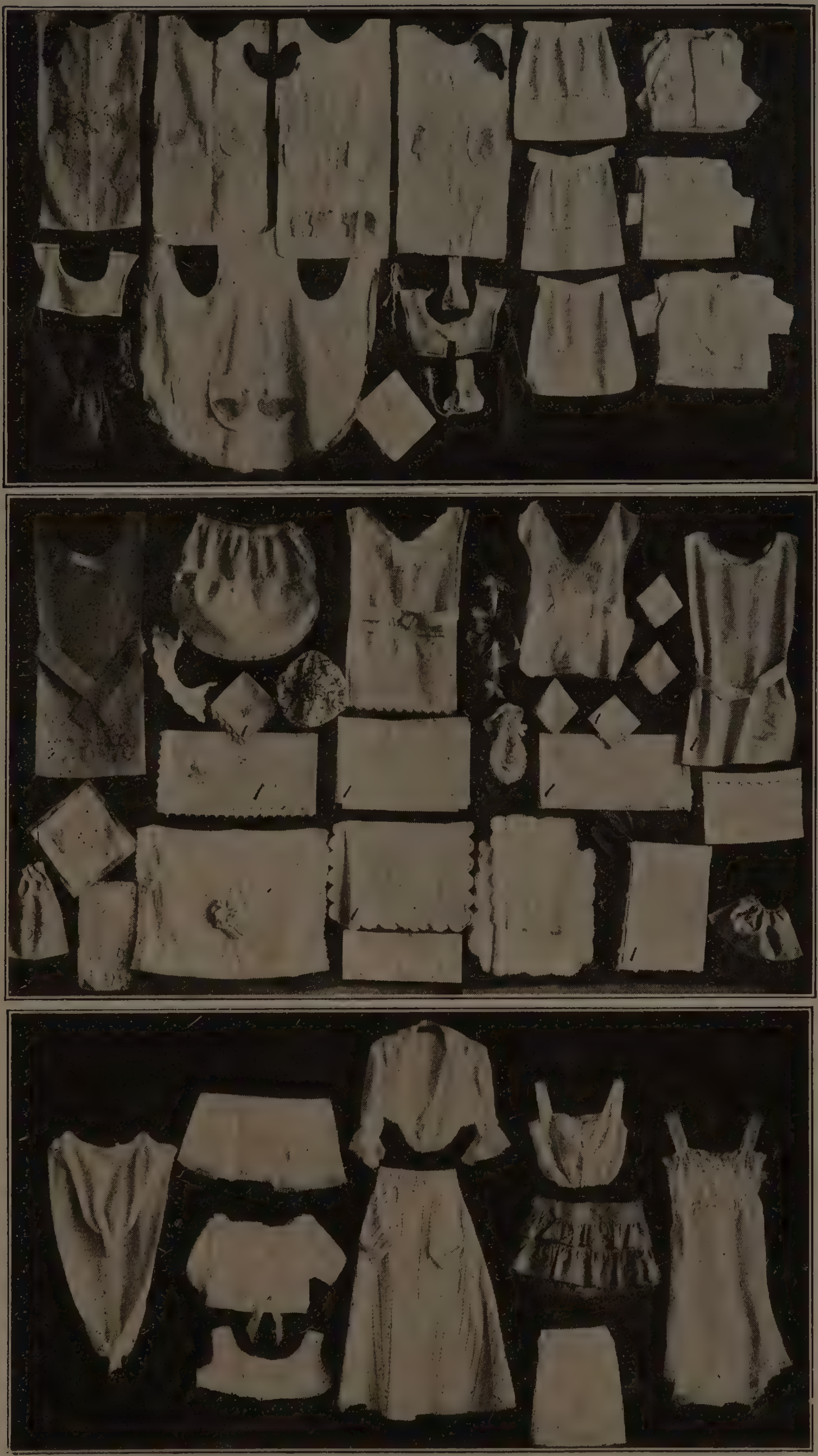


HOW TO TAKE MEASUREMENTS

89. Type Lesson. MAKING OF A WASH CLOTH. GRADE 4. (a) PUPIL'S PREPARATION. Stitches known by the child. Running stitch; back stitch; hemming stitch; cross stitch; blanket stitch; catch stitch.

(b) TEACHER'S PREPARATION. Material. White outing flannel; red and blue Turkish cotton, white thread, No. 50, for basting.

(c) TOOLS. Scissors; needle to carry No. 50 thread, one to carry embroidery thread; tape and thimble. Illustration of



WORK OF SEWING CLASSES

wash cloths of other materials; cheese cloth; Turkish toweling; woven material and harsher crash.

(d) TEACHER'S AIM. (1) Cutting, folding and making wash cloth with round corners.

(2) Reasons why a well finished one is best.
(3) Reasons for round corners.
(4) Best material and why?
(5) Why mark wash cloths?
(6) Why each has his or her own.
(7) How to keep sweet and clean.
(8) Ways to finish.
(9) Dangers to health if not kept clean.

(10) Disciplinary training. Careful listening and thinking, ready and accurate replies, neat work. Teach the saving of time, and motions, and the satisfaction to class of good work.

(11) Teach gathering first, turning of hem next so that corner will lie flat.

(e) PREPARATION OF CLASS. How many have their own wash or face cloth? Have you cloths like these at home? Show various kinds above suggested. Why do we have to use these cloths several times a day? Why do we have round corners? What materials are best and why? How is the best way to use wash cloths? How large should they be and why?

(f) STATEMENT OF AIM TO CLASS. How many know the way to make a wash cloth look well, clean easily, wear well and be soft to the skin?

You know how to turn, hem, baste and catch stitch. Select material and color of thread for finishing hem with feather or catch stitch.

(g) THE LESSON. (1) Selection of material. What material will each select and why?

(2) Cutting. How to measure. How large shall we cut? Why? How be sure the edges are straight so as to finish easily and neatly.

(3) Accurate folding. How shall we cover raw edges? What stitches will hold them best?

(4) Selection of stitches. Guide children in choice. Give out material.

(5) Sewing. The teacher helps individuals and sees that work is neatly done.

(6) Closing lesson. How many have material at home which could be used for more? What material would you buy and how much should you pay for it? How many could make one at home? Put work away neatly, marked so that each pupil can tell her own work next time.

90. Darning. (a) RUNNING DARN. Thin places in stockinet or in woven material, and broken places in the latter may be strengthened by running darns. A number of lines of running stitches are placed close together over the worn part on the wrong side and the stitch and the space alternate in succeeding rows. In stockinet, small loops should be left at the end of each row to allow for stretching or shrinkage, and the edges of the darn should be waved or diamond shaped so the strain will be distributed. The plain running stitch may be used in stockinet or ascending and descending loops may be taken with each stitch. In woven material the shape of the darn may be square and the loops need not be long.

(b) STOCKING-WEB DARNING. This manner of darning reproduces the original knitting of the garment. It is the method employed in factories where the machinery has torn the fabric. It is much used in countries where hand-knitted garments are used. It is a more difficult process than the ordinary way of inserting warp and woof and unnecessarily tedious where the darning of ordinary stockings or sweaters is concerned. The method is to clear away loose ends of the stockinet until the hole is square or oblong. Strands of thread are then stretched across the hole and the knitting stitches are built up with darning cotton on these strands. The strands are carefully removed when the knitting is completed.

(c) WARP AND WOOF DARNS. This is a method in general use for repairing both stockinet and woven material. It may be plain weaving or it may actually reproduce the pattern, as is often done in fine damask. In stockinet the warp threads may be inserted in the ascending and descending loops of the knitting, or, where this is difficult for beginners or unnecessarily exact for the class of material, an alternating running stitch may be used for both warp and woof.

91. Rules for Making Button Holes. (1) Cut slit the diameter of the button to be used.

(2) First strand the button-hole by taking one or more long stitches to the extreme end of the slit and back again to the opposite side. The buttonhole stitch will cover these and will be strengthened by them.

(3) Overcast over the stranding. This overcasting must not be deep or it will show.

(4) Take the first button-hole stitch by putting the needle into the slit close to the end and bringing it out far enough from the edge of the slit to avoid danger from ravelling. The thread must be thrown from the eye of the needle under the needle's point in the direction the work is advancing. Turn the corner of the slit by placing the stitches fan-shaped around the end.

92. Sewing Exhibits. Good projects for school exhibits are dressed dolls for children from seven to thirteen years old. Have each garment hand-made and each doll to wear at least three pieces made by the child. Work aprons, fancy aprons, shirt waists, pillows, tatting, crochet and knitting are also good projects. Encourage the children to make the best use of everything connected with their work, and no matter how many failures and discouragements come, show the true American spirit by sticking to it until they have accomplished something definite. Keep cheerful, work patiently and carefully, profit by your mistakes or misfortunes and never give up until you succeed.

One of the main things to teach and emphasize at these exhibits is neatness and relative values. Never allow calico and kitchen aprons to be made by hand with cross stitch and embroidery, but have them quickly and neatly made on a machine. Afternoon and fancy aprons should be made by hand. Button-holes should always be placed in garments and not in models or strips of cloth. Never teach by models, but by things of real use so that work will not be wasted. Discourage over ornamentation and the use of bright colors and too much ribbon trimming. Be sure the blanket stitch is not mistaken for button holes. In judging the above articles the following points should be considered:

(1) Neatness and appropriateness of material and style of cutting.

(2) Machine work—length of stitch and regularity of seams.

(3) All button holes should be hand-made, using the true button-hole stitch.

(4) Buttons should be properly sewed on.

(5) Size of thread should be in keeping with material used.

(6) The dressed dolls should have at least three under-garments and the dress.

(7) The dolls should not be under twelve nor over twenty inches in length.

(a) EQUIPMENT. No good work can be done without good tools. The farmer must have good machinery. The mother must have a good stove and good kitchen utensils. In this work you, too, must have good tools and must keep them in good condition if you hope to do good work. The needles, thread, scissors, tape measure and thimble will be needed. Use fine needles on fine muslins and coarse needles on coarse cloth. Choose thread to suit the kind of cloth you are using.

Needles No. 10 will carry threads Nos. 100-90-80.
Needles No. 9 will carry threads Nos. 90-80-70-60.
Needles No. 8 will carry threads Nos. 70-60-50-40.
Needles No. 7 will carry threads Nos. 50-40-30-20.
Needles No. 6 will carry threads Nos. 20-10.
Needles No. 5 will carry threads No. 10 linen thread and luster cotton.

Sewing Score Card

Suitability of articles to the purpose	25
Beauty and quality of the design	10
Symmetry and accuracy in cutting	20
Harmony of color and material	15
Perfection of stitches	15
Neatness of finish	15
Total	100

HOME MANAGEMENT

93. The Home. Teaching of food and clothing are recognized parts of domestic science, but the work is incomplete unless the home and home management are made a part of the course. These phases are equally important and should be taught to both boys and girls. It is impossible to go into detail with any one phase of this work, but no one is prepared for his work unless certain general facts regarding influences of the home upon the child, its health and general efficiency with its relation to state and national housekeeping are considered. In connection with this division of the chapter, you should read *Personal and Community Hygiene*, Teacher's Guide.

(a) LOCATION. In locating a home the family need to consider carefully a number of conditions, chief among them being:

(1) *Environment.* The natural surroundings and the neighborhood are of first consideration because of their influence in building the character of the children. The choice of vocation of the child even will be affected by his play, playmates and the occupation of the men and women with whom he daily associates, since they give him a like or dislike for the occupations with which he becomes familiar.

(2) *Altitude.* Pure air and pure water are essential to health. For this reason a dwelling house should not be located on low, flat land where drainage is difficult, if not impracticable. Good drainage is essential to pure water and also to the general sanitation of the home. The drainage system should carry off all surplus water in the soil and all waste water from the premises. This water should not be thrown on the ground to seep down into wells or springs. The drains should be of tile and should connect with the sink and water closets. The outlet should be at least three hundred feet from the house, and a greater distance is desirable. The pipe should be laid in clay and should be placed below the frost line. The joints should be air tight. Whenever a drain becomes clogged it should be repaired at once, since its stoppage may lead to the spread of some germ disease, such as typhoid fever or diphtheria.

Air and sunshine should constitute an important feature in the location and construction of a home; so locate that each room may receive the greatest amount of each. To this end it is a good plan to face the sides of the house northeast, southeast, northwest and southwest, instead of east and west and north and south, as is most frequently done.

(3) *Building*. The building called the house or home should have a generous supply of windows. Each person in the family should have his or her individual sleeping room, which should also serve both as a sleeping room and a private place for study or retirement. Sleeping porches should not be neglected. Teach that the house is built for convenience, health and comfort, not for display and social supremacy. The outbuildings should be as few as possible located for convenience, yet to aid in the artistic setting as much as possible; also on the side of the house away from the wind so that odors and diseases are not carried.

(4) *Roads and alleys*. These should also be built for convenience, kept clean and well drained. This not only increases the efficiency of the neighborhood, but develops desirable traits in the individual child.

(5) *Water*. Next to fresh, pure air, pure water is the most vital factor of health. In cities and most large towns, water is supplied through a city water system whose source is usually a river or lake. If this source is selected with proper care and the grounds immediately surrounding it are so safeguarded that the water will not be contaminated by surface water flowing in during heavy rains, it is usually safe. Private sources of water supply are springs and wells, and these are liable to contamination from two sources — surface water flowing into them during rains, and water entering beneath the surface that has soaked into the ground from barnyards, water-closets, and other places where waste water has been thrown. If examined in a glass, this water as it enters the spring or well appears pure, but when subjected to tests given in Section 2, it shows the presence of organic impurities. Much sickness and doubtless some deaths are caused from water contaminated

in this way. The ground around the mouth of a well or spring should be so guarded that surface water cannot flow in. Deep wells are safer than shallow wells, because the water in them is not so liable to be contaminated. In every instance the well should be lined its entire depth with cement, so that water cannot enter through the walls. Barns and outhouses should be located on lower ground than the wells or springs from which water is taken for drinking and cooking purposes.

(6) *Plumbing.* Defective plumbing is a prevalent source of disease. Teach the pupils how traps are constructed, their purpose, and how they can be cleaned. Plumbing should be open, so that any defect can be detected at once. There should be as little of it as possible, and the simpler the plan upon which it is arranged, the better. Always teach and emphasize that all women should and could have running water in their home. The expense is small considering the returns in comfort and health received.

(7) *Warming and Ventilation.* Whatever method of heating is used, its advantages and disadvantages should be discussed. This will make necessary on the part of the teacher a knowledge of heating by hot water, steam, furnace and stoves. If all these systems are in use in the locality, there should be a discussion of the best methods of managing each. The older boys will probably be able to contribute considerable to this discussion. One cannot save too much fuel and expect good air and heat.

(8) *Removing Dust.* Dust contains particles of effete matter from the breath, the skin and other sources. Whenever there is dust in the air, such impurities as these are inhaled; therefore, its presence in dwellings and public buildings is a menace to health. Discuss the necessity of keeping the house free from dust, and the best methods of removing it.

(9) *The Outlook* of every room of the house is important, but especially should the kitchen, dining room and porches have a pleasant and beautiful view. Again teach that the porch is for comfort and health, not for outside show. For this reason build it on the secluded or private side of the house,

away from the street, that the busy housewife may feel free to relax and enjoy a few spare moments away from the curious public. Encourage the cultivation and care of lawns, flowers and conservation of trees. Study rotation of blooming plants and hardy shrubs.

(10) *Location* in relation to educational institutions, such as schools, churches, libraries, traveling libraries, lecture and music courses and places of legitimate amusements. Study and encourage as much as possible the using of churches and schools as social centers. See *The Community Center*, Teacher's Guide.

(b) EXTERIOR. Following location, the study of types of architecture in relation to surroundings, conveniences, and amount expended upon the home can be considered. The exterior color scheme should fit into the surroundings.

(c) INTERIOR. The size of the rooms is of less importance than the number and location. It is better to have no dining room, having the table in the living room or even in the kitchen, than sacrifice the separate bedroom for each member of the family. This bedroom is an individual room for privacy and a place for study and meditation. It gives opportunity for self development and culture nothing can replace. The American people are growing too fond of excitement and many cannot entertain themselves for a single evening. It is quite important that each room should have a door independent of the other rooms.

(d) FURNISHINGS. What constitutes the proper furnishing of a home, and by what principles one should be guided in furnishing a home, are two questions which should receive attention. The teacher can, by questions and the assignment of work, obtain from the members of the class their ideas on this topic, and the knowledge thus gained will furnish a good basis upon which to plan the lessons. In giving their ideas, some of the girls will unconsciously describe their own homes or the homes of intimate friends. The lessons given should include the discussion of the following points:

(1) *Style and Location of House.* A house located in the

country, the suburb of a city, or in a small town or village, where it has plenty of light on all sides, will admit of very different treatment from a flat in a crowded city where light may possibly enter from only two sides and some rooms may never receive direct sunlight. Again, the furnishings should be in harmony with the size and style of the house. Massive furniture, for instance, is out of place in a cottage or small flat; however, in selecting light furniture one should take care to select that which is strong enough to be durable. Dark furniture placed in one room and light in another gives more pleasing and restful effects than where used together. Be sure lines are simple and good. Avoid carving or places to collect dust.

(2) *Means*. In planning the furnishing of the house, one should first determine the amount that can be expended, then make such selections within these limits as will make the home comfortable and at the same time have the furnishings harmonize in color and relative cost. To illustrate: A single expensive piece of furniture in a room where all other pieces are of moderate cost, seems out of place, and the money invested in it can be used more wisely in the purchase of a number of substantial pieces which, as a whole, will add more to the pleasure and comfort of the home because they are more useful. In general, a few well constructed, serviceable pieces of furniture are much more desirable than a larger number of cheap, showy pieces which must soon be repaired or replaced.

(3) *The Rooms*. Having discussed the foregoing principles, apply them to the furnishing of the different rooms.

The Kitchen. The duties of the day begin in the kitchen. Since the homemaker spends more than half of her working hours in the kitchen, it should be a room well lighted and aired, pleasantly located as to outlook and as convenient as possible. Teach that time, labor and steps are saved if the furniture is properly placed. This can be done by drawings. Tables, stoves, and cupboards should be of proper height. The average stove, table and sink is about three inches lower than it should be for the average height woman. This can be remedied by blocks and foundations placed under in a way so that dust and dirt can be easily removed. Many more women could have running water and labor saving devices if they were taught the advantages of saving themselves rather than a few dollars.

Have live discussions on the subject, avoid tedious notebooks. Collect pictures of good arrangements of furniture and labor-saving devices, figure cost and saving of labor resulting from their use. Be sure that the kitchens discussed are as near typical of the kitchens and rooms the pupils are used to as possible. Discuss utensils as to cost, wearing qualities and as conductors and non-conductors of heat. See that the pupil realizes that it is quite as important to have a high stool and rocking chair in the kitchen as chairs in other rooms. Also a table on casters to move from place to place. Tea wagons are great conveniences and can be made at small expense. Interest can be increased by having each pupil write a description of her ideal kitchen or each room, then compare the descriptions and discuss the good and bad.

The dining room, living rooms, and bed rooms may be discussed in a similar way, emphasizing convenience, beauty, time and the saving of labor. Discuss such details as pictures, china, table linen, rugs, etc., as time will permit.

(4) *Ornamentation.* The decoration of the walls is inseparable from the furnishings; in order that the home may be the most enjoyable, the color scheme of the walls and the furnishings must harmonize. What this color scheme shall be depends upon the style and location of the home and the taste of the occupants. The most important features of the lessons on ornamentation consist in educating the taste of the pupils so that bright colors, cheap bric-a-brac and poor pictures will be excluded. Lead the pupils to realize that a few choice pictures and other ornaments to match, which harmonize with the walls and furniture, are much more satisfactory and in the end no more expensive. Make each article stand the tests; is it useful? is it desirable? is it durable? is it artistic to the setting?

(5) *Unnecessary Purchases.* In beginning a home it is usually wise to purchase only a part of the entire outfit which the occupants intend to procure. If the first purchases are confined to the necessities, other articles can be added from time to time as experience shows they are needed. Such a plan often prevents the purchase of articles which time proves to be unnecessary. But the lesson on unnecessary purchases should go a step further and show the folly of purchasing anything which is not needed simply because it is a "bargain." The happiness of many a family has been sadly marred, if not wrecked, at the bargain counter. Concerning the evil influence of this institution, Ellen H. Richards says: "What the liquor saloon is to the drinking man, the bargain counter is to the aimless woman." The following comment by the same authority shows the force of the statement:

> Go through a great department store, notebook in hand, and check off the articles which are valueless either for use or ornament and those which with a semblance of either will lose the little value they have the first day of use; then go into the home for which the articles were destined and note the amount of money spent for these things in comparison with that spent for the essentials of good living and for the things which make for moral and mental advancement.— *The Cost of Living.*

94. Home Management. After locating and furnishing the home, lessons in management should follow. (1) Planning the work for the day and week to save time, labor and money.

(2) Marketing. Method and time. Buying in quantity or small amounts.

(3) Care of food, utensils, cupboards, etc. Disposal of waste.

(4) Extermination and prevention of household pests.

(5) Table setting and table manners. Save steps, time and labor.

(6) Care of dining room and kitchen after meals.

(7) Selection of china, silver and table linen.

(8) Sweeping, dusting, vacuum cleaners, carpet sweepers, dustless dusters.

(9) Care of wood work, furniture, rugs, etc.

(10) Care and arrangement of books, flowers and other ornaments.

(11) Selection and care of window hangings, cleaning windows.

(12) Lighting the home. Cost, means and care.

(13) Care of bed rooms, beds, bedding.

(14) Closets.

(15) Bathroom. Plumbing, disinfecting, daily care of. Individual towels and wash cloths.

(16) Storage system. Care of.

(17) Basement or cellar.

(18) Heating system. Construction, cost; fuel, care of.

(19) Laundry. Water, soap, stains, bluing, ironing and conveniences for same.

(20) Study carefully housekeeping as a profession. The division of income, keeping of accounts, etc.

(21) Care of the sick. Emergency work.

(22) Amusements, music and cultural guidance in the home.

Caution. The teacher will have to use care in selecting lessons if the time is limited. Determine as near as possible the greatest needs and select and teach lessons accordingly. Keep constantly in mind lessons in hygiene, sanitation and preventive medicine, in connection with each of the above suggested topics. Clean Up Day can be used to advantage.

SUGGESTED BOOKS OF VALUE AS TEXTS OR REFERENCES

"*Food and Household Management.*" Kime and Cooley.

"*Text Book of Cooking.*" Carlotta C. Greer.

"*Elements of the Theory and Practice of Cookery.*" Williams & Fisher Government Bulletins.

State University and Agricultural Bulletins.

"*Shelter and Clothing.*" Kime and Cooley.

Industrial Geography.

Thirteen Volumes, Library of Home Economics. American School of Home Economics.

"*Cost of Living.*" Ellen H. Richards.

"*Efficient Housekeeping.*" Mrs. Christine Frederick.

Standard magazine articles and illustrations are helpful

TEST QUESTIONS

1. What changes in living conditions make it advisable to teach domestic science in the public schools?

2. How does domestic science bring the home and the school interests into close relationship?

3. Suggest ways in which the teacher may overcome difficulties that hinder the introduction of domestic science in her school.

4. Why is it advisable for one who must plan and prepare meals to have a knowledge of foods and foodstuffs?

5. What should be the scope of the teacher's knowledge on these points?

6. Into what classes are foods divided?

7. What is meant by *hydrocarbons*? *Carbohydrates*?

8. Give examples of each.

9. What is a *protein*. Name the various classes of proteins.

10. What is the value of albumin to the physical organism?

11. In what foods is gluten found? How can it be obtained from wheat?

12. Should an invalid be fed solely on meat extracts? Give reasons for your answer.

13. What is the special function of fat as a food?

14. Why should starchy foods be cooked?

15. What are the beneficial effects of sugar as a food?

16. How does the saliva assist in the work of digestion?

17. What are the most important acids found in fruits and vegetables?

18. What is the importance of obtaining pure drinking water?

19. Describe two practical tests for ascertaining the purity of water.

20. Why is a diet of both vegetables and meat preferable to one of vegetables alone?

21. Name the chief reasons for cooking food.

22. In what three ways is heat transmitted? What is the application of this to cooking?

23. Name and discuss three methods of teaching cooking.

24. Why should correct weights and measures be used in teaching cookery?

25. What is a *calorie*? Why should a teacher of domestic science understand the meaning of this term?

26. Outline a model lesson on fuels.

27. Show how you would teach the various uses of water.

28. What are the essential things to emphasize in a lesson on fruits?

29. Outline a lesson on carbohydrates. What laboratory work should be assigned?

30. What practical truths may be brought out in a lesson on salads?

31. Why should eggs be served with some starchy food?

32. What are the various cuts of beef, pork and veal?

33. What are the five leavening agents employed in cookery?

34. Write out a balanced ration for one day.

35. What points are considered in judging bread?

36. How would you teach a lesson on the lunch-box?

37. How are domestic science contests conducted? What good results from them?

38. What rules would you give in teaching a class in sewing?

39. Name the important stitches a sewing class should learn.

40. Outline a type lesson on darning; on making button holes.

41. Why should home management be a part of the course in domestic science?

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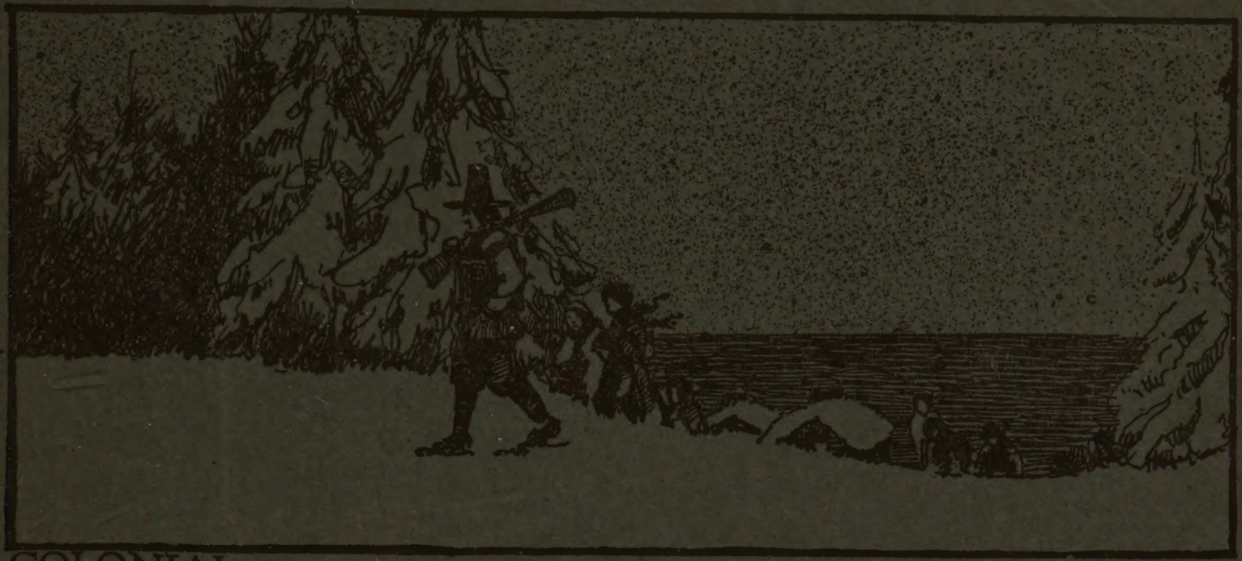

COLONIAL

THE SECRET OF EDUCATION LIES IN RESPECTING THE PUPIL

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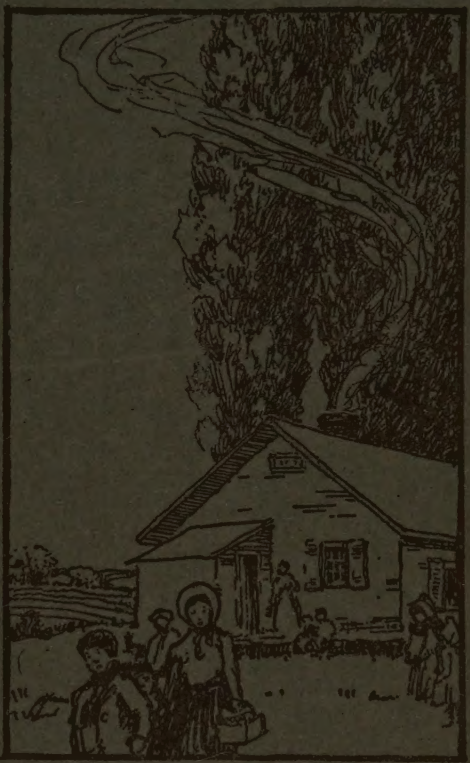

PIONEER

MODERN

T.W. STEVENS